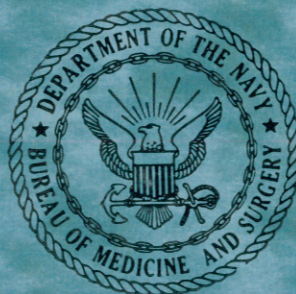


NAVY INDUSTRIAL ENVIRONMENTAL HEALTH BULLETINS



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NAVY

ENVIRONMENTAL

HEALTH

BULLETINS



DEPARTMENT OF THE NAVY
BUREAU OF MEDICINE AND SURGERY
WASHINGTON, D.C. 20372

IN REPLY REFER TO

FOREWORD

The fulfillment of the Medical Department's mission to safeguard the health of military and civilian personnel of the Navy and Marine Corps requires close surveillance of the occupational environment.

The rapid advancements in military/industrial technology result in a continuing flow of new products and processes into the work environment. Many of these products are potentially hazardous to health unless used under carefully monitored and controlled conditions.

This series of bulletins is provided to assist Medical Department personnel in recognizing industrial chemicals or processes hazardous to health and in evaluating the conditions under which they are being used.

A handwritten signature in cursive script, reading "C. L. Waite", is positioned above the typed name.

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NAVY ENVIRONMENTAL HEALTH BULLETINS

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CHAPTER 1

INTRODUCTION

These Bulletins are issued by the Navy Environmental Health Center (NAVENVIRHLTHCEN) which has a direct responsibility to provide environmental health services to the Navy and thus our country and its people. A concise factual statement about potential problems associated with the use of modern science and technology in a military industrial environment is given and guidance on how to avoid personal injuries or to care for them should they arise.

The Bulletins assume a degree of professional ability and judgment in those for who they are intended. The users of the Bulletins are expected to determine for themselves the detailed nature and extent of action required in a given set of circumstances.

The format and content of the Bulletins are uniformly organized. The first item contains the critical health standards of TLV, EEL, and the concentration immediately hazardous to life. The next item is a tabulation of the important physical and chemical properties of the agent. Following these there are sections discussing toxic hazards, special hazards, precautions and controls, storage and handling, and special medical information. Appended to each Bulletin is a "Hazard Notice" that is to be copied and posted for all potentially exposed employees to study. It describes the hazards of the agent in brief, simple language and gives clear, direct precautionary and emergency procedures.

Recognizing that health standards such as TLV's are subject to change provision is made for keeping this kind of information up to date by means of an appendix to be issued annually. In those cases where EEL's or similar standards for acute exposures are not available the most applicable animal data will be given.

The vapor pressure data can be used to calculate quickly the saturated air concentration at the temperature of exposure. This value can then be compared to the EEL or the concentration immediately hazardous to life. The environmental specialist on the scene of a major spill can thus assess the degree of hazard promptly.

INTRODUCTION

The nature of both the acute and chronic toxicity hazards from an agent are described in the next section. The major routes of entry into the body are given with quantitative data on levels causing injury. The target organs and other effects are identified. The special hazards section is intended to call attention to unique toxic properties of the agent such as delayed responses, lack of warning properties, or cumulative action.

The precautions and environmental control section contains guidance on the standards for proper exhaust ventilation and monitoring procedures. Special precautions for storage, transfer, and other handling are given in the next section, storage and handling, with emphasis on incompatibility, decomposition, corrosivity and similar problems.

Medical personnel will find the section on special medical information to be of particular interest and importance. It has two parts, one on preplacement and periodic examinations, the other on emergency treatment. In both parts only the information unique to the particular agent is given as a supplement to the physician's basic skills in providing supportive treatment.

In general the following policies and procedures apply to all preplacement examinations:

A. Pulmonary system. Individuals with a strong history or evidence of respiratory tract disorders, for example impaired vital capacity, should not be placed where they could be exposed to materials producing severe respiratory effects upon over-exposure. It is inadvisable to place employees with inactive or arrested tuberculosis or those with scarring or partial pneumonectomy in dust areas.

B. Vision. Persons with monocular vision due to loss or blindness of one eye are not felt qualified for exposure to materials that could cause severe injury upon accidental entrance into the good eye. Mandatory wearing of eye protection does not suffice to waive this restriction since such injury could result in total blindness.

Employees wearing contact lenses should be excluded from dusty areas and those presenting eye hazards. Accidental introduction of foreign materials into an eye with a contact lens is much more likely to produce serious damage.

INTRODUCTION

Periodic examinations involve the following general considerations subject to the judgment of the responsible physician. The frequency and extent of a periodic examination should be based on a knowledge of the nature, duration, and degree of exposure of the individual employee. Many workers are commonly exposed to several health hazards during their work period. Accordingly the periodic examination should be reasonably comprehensive including hematology, blood chemistry and vital capacity determinations along with special studies related to the specific hazards. The periodic examination can easily be combined with a general health maintenance evaluation.

Ordinarily employees in modern facilities with properly designed and conducted operations will not need examination more than annually. A known or suspected over-exposure may well require one or more special examinations. If the working conditions are significantly below standard or if a particularly hazardous substance is involved it could be desirable to conduct more frequent health evaluations. In these circumstances the responsible physician should request advice and recommendations for procedures from the NAVENVIRHLTHCEN.

Physicians and all others concerned with employee health are reminded of their continuing responsibility for maintaining up to date knowledge and skills related to the hazards facing the employees under their jurisdiction. At the same time they should assure themselves that those employees having potential hazardous exposures have been properly trained. Such training should include education in the toxic effects, knowledge of indicated personal hygiene practices, and appropriate emergency procedures.

For those seeking more detailed knowledge than that found in standard references such as the AIHA Hygienic Guides or the Handbook of Poisonings issued by Lange Medical Publications, Inc., the assistance of NAVENVIRHLTHCEN is available.

CHAPTER 2
LIST OF BULLETINS

Acetic Acid

syn. Ethanoic acid, Vinegar acid, Methane carboxylic acid

Acetone

syn. Dimethyl ketone, Ketone propane, 2-Propanone

Acetylene Dibromide

syn. Diboromo ethyne

Acrolein

syn. Acrylaldehyde, 2-Propenal, Aeraldehyde, Allyl aldehyde

Acrylonitrile

syn. Propenenitrile, Vinylcyanide

Allyl Alcohol

syn. 2-Propen-1-ol, Propenyl alcohol

Allyl Glycidyl Ether

syn. 1, 2-Epoxy-3-allyloxy propane, 1-Allyloxy-2, 3-epoxy propane

Aluminum Alkyls

Aluminum and Aluminum Oxide

Ammonia (Anhydrous)

Ammonia (Aqueous)

syn. Ammonia liquor, Ammonia water, Ammonical liquor, Ammonium hydrate, Ammonium hydroxide, Aqua ammonia

Ammonium Nitrate

syn. Norway saltpeter

Ammonium Picrate and Picric Acid

syn. Ammonium carbazotate, Ammonium picronitrate

Aniline

syn. Aniline oil, Phenylamine, Aminobenzene

Arsenic and Arsenic Compounds

(except Arsine)

Arsine

syn. Hydrogen arsenide, Arseniuretted hydrogen, Arsenic hydride

LIST OF BULLETINS

Asbestos and Asbestos Compounds

Barium and Inorganic Barium Compounds

Benzene

syn. Benzol, Phenl hydride, Coal naphtha, Cyclohexatriene

Beryllium

syn. Glucinium

Boranes (di-, Penta-, and Deca-)

syn. Boroethane, Boron hydride, Diboron hexahydride

Bromine

2-Butanone

syn. MEK, Methyl ethyl ketone, Ethyl methyl ketone

Cadmium and Cadmium Oxide

Calcium Chloride

Calcium Sulfate

syn. Gypsum, Terra alba

Carbon Black

syn. Channel black, Furnace black, Thermal black

Carbon Disulfide

syn. Carbon bisulfide

Carbon Monoxide

Carbon Tetrachloride

syn. Tetrachloromethane, Perchloromethane, Carbon tet

Caustics

syn. Sodium and Potassium hydroxides (Caustic soda, Caustic potash, Potassium and Sodium hydrates, Lye)

Chlorates and Perchlorates

syn. (ClO_3^-) and (ClO_4^-)

Chlorine

Chlorine Trifluoride

Chlorodiphenyls

Chromates and Dichromates

Chromic Acid

syn. Chromic anhydride, Chromium trioxide

Cresol

syn. Cresylic acid, Cresylol, Tricresol, Hydroxyluene, Orthocresol, Metacresol, Paracresol, Methyl phenol, Hydroxymethyl benzene, Hydroxylene

Cumene

syn. Isopropyl benzene, Phenyl isopropane, Cumol, 2-Phenylpropane, Isopropylbenzol, Isopropylbencol

Cyanides

syn. Sodium & Potassium cyanides, Cyaniegg, Cyanoflake, Cyanogran, Perliton

Cyclohexanone

syn. Pimelic ketone, Ketohexamethylene, Cyclohexyl ketone

Cyclonite Hexagon

syn. Cyclotrimethylene, Trinitramine, RDX

Cyclotetramethylene Tetranitramine

syn. Homocyclonite, HMX

Diisocyanates

syn. p,p'-Diphenylmethane-4, 4-diisocyanate, TDI, Toluene-2, 4-diisocyanate. M Tolylene diisocyanate, 2,4-Tolylene Diisocyanate

Dimer Fuel RG41, 1-Dimethylhydrazine

syn. Unsymmetrical dimethylhydrazine, UDMH, Aerozine

1,4-Dioxane

syn. Diethylene, -1,4-dioxide, Diethylene ether, Diethylene oxide, Eioxyethylene ether

Epichlorohydrin

syn. 1-Chloro-2, 3-epoxypropane, Dichloropropylene oxide, Epi

Epoxy ResinsEthyl Acetate

syn. Acetic ester, Acetic ether, Vinegar naphtha

Ethyl Acrylate

syn. Acrylates, Ethyl propenoate

Ethylene Glycol

syn. 1,2-Ethanediol, Ethylene alcohol, Glycol, Glycol alcohol

LIST OF BULLETINS

Ethylene Glycol Dinitrate

syn. Nitroglycol, Dinitroglycol, EGDN, Ethylene glycol nitrate, EGN

Ethylene Glycol Mono-n-butyl Ether

syn. 2-Butoxyethanol, Butyl cellosolve, Dowanol EB

Ethylene Oxide

syn. 1, 2-Epoxyethane, Oxirane, Dimethylene oxide

Ethyl Ether

syn. Anesthesia ether, Diethyl oxide, Ether, Ethoxyethane, Ethyl oxide, Sulfuric ether, Diethyl ether

Fluoride Bearing Dusts (inorganic)

Fluorine (gas)

Formaldehyde

syn. Methanal, Methyl aldehyde, Formic aldehyde, Oxymethelene, Formalin, Methylene oxide, Para formaldehyde

Furfural and Fural

syn. Furaldehyde, Furfuraldehyde, 2-Furancarboxal

Gaseous Petroleum Hydrocarbons

	syn.
Methane:	Marsh gas, Methyl hydride
Ethane:	Dimethyl, Ethyl hydride, Methyl methane
Propane:	Dimethyl methane
Butane:	n-Butane, Butyl hydride
Liquified Petroleum Gases:	LP gas, LPG, Acetogen, Progas, Rockgas, Pyrofax
Ethylene:	Bicarburetted hydrogen, Ethene
Acetylene:	Ethine, Ethyne
Methylacetylene:	Allylene, Propyne
Methyl Acetylene Propadiene Mixture:	MAPP
1,3 Butadiene:	Vinylethylene, Erythrene, bi-or di-vinyl

Hexone

syn. Isopropyl acetone, Methyl isobutyl ketone, 4-Methyl-2-pentanone, MIBK

Hydrazine

syn. Diamine, Hydrazine anhydrous, Hydrazine base

Hydrogen Chloride

syn. Hydrochloric acid mist, Muratic acid, Anhydrochloric acid, Hydrochloric acid

Hydrogen Cyanide

syn. Hydrocyanic acid, Prussic acid, Formonitrile, HCN

Hydrogen Fluoride

syn. Hydrofluoric acid mist, Anhydrous hydrofluoric acid, Aqueous hydrofluoric acid

Hydrogen Peroxide

syn. Hydrogen dioxide, Perhydrol, Peroxide

Hydrogen Sulfide

syn. Sulfuretted hydrogen

Hydroquinone

syn. 1, 4-Benzenediol, Hydroquinol, para-Hydroxybenzene, Quinol

Iron Phosphate

syn. Ferric phosphate

Iron Oxide

syn. Ferro-ferric oxide, Magnetite, Iron Subcarbonate, Burnt sienna, Indian red

Isopropyl Alcohol

syn. Avantine, Dimethyl carbinol, Isopropanol, Petrobol, Propanol, 2,2 Propanol, sec-Propyl alcohol

Lasers and MasersLead and Lead CompoundsLiquid Petroleum Hydrocarbons

syn.

n-Pentane:

Petroleum Naphthas:

Amyl hydride

Heptane, Hexane, High Flash Mineral Spirits, High Flash VM&P Naphtha, Kerosene, Lacquer Diluent, Mineral Spirits, Mintrol Spirits, Rubber Solvent, Stoddard Solvent (for further information see separate bulletin on Stoddard Solvent), Textile Spirits, VM&P Naphtha

Cyclohexane:

Hexamethylene, Hexanaphthene, Hexahydrobenzene

Turpentine:

Wood Turpentine, Gum Spirits of Turpentine, Oil of Turpentine

Gasoline:

Petrol, Motor Spirits

n-Heptane:

Dipropylmethane

Magnesium and Magnesium Oxides

LIST OF BULLETINS

Magnesium-thorium Alloy (radioactive)

Manganese and Inorganic Manganese Compounds

Mercury and Inorganic Mercury Compounds
syn. Quicksilver

Mercury Organic (fulminate)

Methyl Alcohol

syn. Methanol, Carbinol, Wood spirits, Wood naphtha, Wood alcohol, Colonial spirits, Columbian spirits, Methyl hydrate, Methyl hydroxide, Sterno

Methyl Chloroform

syn. 1,1,1-Trichloroethane, Alpha trichloroethane, Beta trichloroethane

Methylene Chloride and Bromide

syn. Dichloromethane, Methylene dichloride, Methylene bichloride, Chloromethane, Dibromomethane, Bromomethane, Methyl bromide, Methylene dibromide

Microwave Radiation

Nickel Carbonyl

syn. Nickel tetracarbonyl

Nitric Acid fuming (red and white)

syn. RFNA, WFNA

Otto Fuel II

syn. OFII

Oxalic Acid

Oxides of Nitrogen

syn. Dinitrogen tetroxide, Nitrogen peroxide, Liquid nitrogen dioxide, Dioxide (liquid), Nitrogen (liquid), NTO, Nitrous oxide, Nitrogen dioxide, Nitrogen tetroxide

Ozone

Pentachlorophenol

syn. PCP

Phenol

syn. Carboic acid, Hydroxybenzene, Monohydroxybenzene, Phenyl hydroxide

Phosphine

syn. Hydrogen phosphide, Phosphoretted hydrogen

Phosphoric Acid (Ortho) or (Glacial)

Phosphorus (red)

Phosphorus (white or yellow)

Potassium Nitrate

Silica (amorphous crystalline)

syn. Free silica, Silicon dioxide

Silicates (mica soapstone, Portland cement, soapstone, talc, trimolite); asbestos containing less than 1% crystalline silica

Sodium Phosphate

Stibine

syn. Antimony hydride

Stoddard Solvent

Styrene Monomer

syn. Phenylethylene, Vinylbenzene, Stryrolene, Stryol, Cinnamene, Cinnamol, Styrene

Sulfur Dioxide

syn. Sulfurus acid anhydride

Sulfuric Acid

syn. Oil of vitriol, Hydrogen sulfate, Battery acid

Teflon and Kel-f

syn. Polytetrafluoroethylene, Kel-F-Polymonochlorotrifluoroethylene

Tetraethyl Lead

syn. TEL

Tetryl

syn. Tetryol, Tetralite, 2,4,6-trinitrophenylmethyl nitramine, Nitramine, N-Methyl-N, 2,4,6-Tetranitroaniline

Titanium and Titanium Dioxide

syn. Titania, Titanic acid anhydride, Titanic anhydride, Titanic oxide, Titanium white, Rutile, Anatase

TNT

syn. Trinitrotoluene, Dinitrotoluene, DNT

Toluene

syn. Toluol, Methyl benzene, Phenylmethane

LIST OF BULLETINS

Triethylborane

syn. Triethyl boron, Boron triethyl, TEB, Triethyl borine

Triorthocresyl Phosphate

syn. Tri-O-Tolyl phosphate, Ortho tolylphosphate, Tricresyl phosphate, TCP, TOCP, Tri-Tolyl phosphate

Xylene

syn. Xylol, Dimethyl benzene

Zinc and Zinc Oxide (fumes)

Zinc Phosphate

syn. Zinc orthophosphate, Zinc Phosphate Tri-basic

CHAPTER 3

BULLETINS

The bulletins are to be filed in alphabetical order and will be updated as necessary. Useful information pertaining to the bulletins can be found in the appendices.

- (1) Appendix A - Threshold Limit Values
- (2) Appendix B - Emergency Exposure Limits
- (3) Appendix C - A Glossary with pertinent terms, definitions, and formulas
- (4) Appendix D - A cross-reference list containing the names of all the bulletins and their respective synonyms

If any further information or assistance is required, contact either the Navy Environmental Health Center, 3333 Vine Street, Cincinnati, Ohio 45220 at (COM) 513/684-3863, (AV) 989-3863, or the Bureau of Medicine and Surgery (Code 56) Washington, D. C. 20372 at (COM) 202/254-4620, (AV) 294-4620.

NAVY INDUSTRIAL ENVIRONMENTAL HEALTH BULLETIN

BARIUM AND INORGANIC BARIUM COMPOUNDS

SYNONYMS: None

THRESHOLD LIMIT VALUE (1973)*: 0.5 mg/M³ (Barium and soluble barium compounds)

EMERGENCY EXPOSURE LIMITS*: None set

ATMOSPHERIC CONCENTRATIONS IMMEDIATELY HAZARDOUS TO LIFE:
Unknown

SIGNIFICANT PROPERTIES: Barium is a yellowish-white to silvery metal. It ignites spontaneously in the presence of moisture as it evolves hydrogen. Water-soluble barium compounds may be regarded as poisonous. Soluble barium compounds of industrial importance are the carbonate, chloride, hydroxide, nitrate and oxide. Barium sulfate, however, having a low solubility, is used in gastrointestinal radiography.

Chemical Formula	Ba
Atomic Weight	137.36
Boiling Point	1638°C (2948.4°F)
Melting Point	704°C (1267.5°F)
Solubility	Reacts exothermically with water; soluble in acids, decomposes in alcohol
Vapor Pressure	10 mm Hg @ 1049°C (1884°F) 100 mm Hg @ 1301°C (2342°F) 760 mm Hg @ 1638°C (2948.4°F)

USES: Barium compounds are used in paints as pigments. They are found in explosives and pyrotechnics and are used in laboratories.

1. PHYSIOLOGICAL HAZARDS

A. Inhalation - Inhalation may result in bronchial irritation. Pneumoconiosis and baritosis have been reported in cases of long continuous exposure to barium compound dusts.

B. Skin Contact - There seems to be no general response by individuals exposed to barium compounds with the exception of barium sulfide, which may cause skin irritation. Cut and

*See Appendices A and B for current values.

BARIUM AND INORGANIC BARIUM COMPOUNDS

abraded skin should be covered. When handling these compounds, metallic barium should not be handled as it decomposes exothermically in the presence of moisture.

C. Eye Contact - Contact of barium compounds with the eye may cause severe irritation or burning. Metallic barium would decompose, causing severe burns.

D. Ingestion - Barium and soluble barium compounds should be considered as poisonous. Barium carbonate (BaCO_3) has been used as a rat poison.

II. SPECIAL HAZARDS

A. Metallic barium reacts with moisture to produce hydrogen which is explosive.

B. Barium peroxide (BaO_2), nitrate ($\text{Ba}[\text{NO}_3]_2$), and chlorate ($\text{Ba}[\text{ClO}_3]_2$) present fire hazards in use and storage.

III. PRECAUTIONS

A. Personal Protection - (See Safety Equipment Manual NAVMAT P-10470 July 1969 for appropriate protective equipment)

1. Inhalation - Provide approved local exhaust ventilation for exposure to dusts of barium and barium compounds. For short term emergency exposures respiratory equipment approved by the U.S. Bureau of Mines/NIOSH for inorganic dust exposure may be used.

2. Skin Contact - Light impervious gloves should be worn by personnel exposed to dust of barium and barium compounds. Hands should be washed before eating, drinking, or smoking.

3. Eye Contact - Chemical workers' goggles should be worn by personnel working with these materials.

4. Ingestion - Wash hands before eating, drinking, or smoking. No food should be allowed in areas where exposure to barium compounds is possible.

B. Environmental Protection

1. Provide approved local exhaust ventilation for all operations where barium and barium compounds are used.

BARIUM AND INORGANIC BARIUM COMPOUNDS

2. Eye wash fountains should be provided in areas where there is a potential for exposure to barium compounds.

IV. STORAGE - Storage of barium and barium compounds should be in accordance with manufacturers recommendations. It should be noted that metallic barium, barium peroxide, nitrate, and chlorate present a potential for fire.

V. DISPOSAL AND SPILLAGE - The disposal of this material should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instruction of each activity or base.

VI. HANDLING - All above noted personnel protective equipment should be provided in addition to ventilation to control any inhalation hazard where that potential exposure exists. Precautions should be taken in consideration of the potential fire hazard and any other handling recommendations or precautions noted by the manufacturer should be followed.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - Persons with history or evidence of chronic lung conditions or active dermatitis should be excluded from exposure.

2. Periodic - Vital capacity determinations should be included.

B. Toxic Effects - Dust may cause respiratory and skin irritation. Soluble salts are readily absorbed if ingested and exert severe toxic effects on the neuromuscular system.

C. Treatment - Gastric lavage followed by symptomatic treatment is indicated. In severe cases, lavage with sodium sulfate to precipitate the barium followed by catharsis has been recommended. Muscular paralysis has been ascribed to displacement of potassium, hence potassium infusion may be considered. Arrhythmias may occur and should be dealt with according to the specific type.

BARIUM AND INORGANIC BARIUM COMPOUNDS

HAZARDS

The inhalation of barium and its compounds may cause bronchial irritation. Contact with the skin of the sulfide can produce irritation. Eye contact can produce severe burning and irritation. Barium and soluble barium compounds should be considered as poisons, and care should be taken to ensure they are not taken internally.

EMERGENCY PROCEDURES

1. Inhalation - Remove to fresh air. Report to Medical
2. Skin - Wash skin thoroughly with soap and water.
3. Eyes - Wash eye for 15 minutes with water. Report to Medical.
4. Ingestion - Induce vomiting and secure medical assistance.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

BERYLLIUM

SYNONYMS: Glucinum

THRESHOLD LIMIT VALUE (1973)*: 0.002 mg/M³

EMERGENCY EXPOSURE LIMIT*: None set

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE:
Unknown

SIGNIFICANT PROPERTIES: Beryllium is a grayish-white,
brittle hard metal.

Atomic Number	4
Atomic (or molecular)	
Weight	9.01
Density @ 25°C	1.85
Melting Point	1285°C (2345°F)
Boiling Point	2970°C (5378°F)
Solubility	Soluble in dilute acids and alkalis
Vapor Pressures	
890°C (1634°F)	7.6X10 ⁻⁶ mmHg
1080°C (1976°F)	7.6X10 ⁻⁴ mmHg
1330°C (2426°F)	7.6X10 ⁻² mmHg
1810°C (3290°F)	7.6 mmHg
Color	Gray-White

USES: Beryllium metal has wide use in the field of nuclear energy because of its low neutron absorption and its ability to produce neutrons when bombarded with alpha particles. It is also used in gyroscopes for missiles. Beryllium (generally 4% or less) alloyed with copper or nickel is used in such items as springs, gears, safety tools, hypodermic needles, and other surgical instruments. Beryllium oxide is an excellent high temperature ceramic material. It was used as a phosphor in fluorescent light tubes prior to 1949. Since that date, a harmless substitute has been in use. Rocket propellants may be enriched by the addition of Beryllium.

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Inhalation of beryllium and its compounds may produce two types of disease - acute and chronic.

* See Appendices A and B for current values

BERYLLIUM

1. Acute - Acute disease may result from relatively brief exposure to high concentrations of beryllium or its compounds. The result may be a pneumonitis where exposure is to the metal or its compounds. Nasopharyngitis or tracheobronchitis is more likely from highly soluble compounds.

2. Chronic - Chronic disease may result from varying lengths of exposure to a wide range of concentrations including quite low concentrations. Pulmonary manifestations usually include dyspnea and a chronic cough. Significant weight loss within a short period of time is a symptom in many cases as are anorexia, fatigue, weakness, and malaise. Although respiratory symptoms are most prominent and usually occur first, the chronic disease is considered by many to be a systemic disease which may involve other organs. Chest x-rays are useful in diagnosis and treatment but only in conjunction with other clinical findings.

B. Skin Contact - Skin contact with soluble salts, particularly acidic salts, may produce dermatitis of primary irritant or sensitization type. Accidental implantation of beryllium or its compounds beneath the skin may cause necrosis of adjacent tissue with the formation of an ulcer. Implantation of comparatively insoluble compounds may produce a granuloma. Healing doesn't occur unless the beryllium-containing material is completely removed.

C. Eye Contact - Conjunctival inflammation may accompany contact dermatitis resulting from soluble beryllium compounds.

D. Ingestion - No harmful clinical effects have been reported from ingestion of beryllium-containing materials.

II. SPECIAL HAZARDS

A. A hazardous concentration of beryllium fume may be vaporized when heating the metal above 1400°F (760°C).

B. Fire hazard-moderate, in the form of dust or powder; or when exposed to flame by spontaneous reaction. Severe health hazards may become imminent as the result of a fire.

III. PRECAUTIONS

A. Personal Protection (See Safety Equipment Manual NAVMAT P-10470 current edition for appropriate protective equipment).

1. Inhalation - Local exhaust equipment must be provided for personnel exposed. For short term emergency exposures, respirators may be used. All respirators must be U.S. Bureau of Mines/NIOSH approved for the specific hazard conditions and the exposures of concern.

2. Skin Contact - Scrupulous adherence to good housekeeping practices, plant and personal cleanliness are an obvious necessity. Lacerations and abrasions with beryllium-containing materials, especially where beryllium compounds are implanted in the tissue, are difficult to heal. There is no danger in ordinary skin contact with beryllium metal, alloys, or fused ceramic material. Protective clothing, laundering control, locker, shower, and toilet facilities shall be provided.

3. Eye Contact - Eye protective devices should be worn when working with soluble beryllium compounds under conditions where splashing or mist production can occur.

4. Ingestion - No special precautions other than those used in handling most chemicals.

B. Environmental Protection

1. All operations involving the generation of beryllium fumes, mists, dusts, or vapors, must be done with local exhaust ventilation.

2. Records shall be maintained of environmental exposures.

IV. STORAGE - Beryllium metal should be stored in such a way that it will not come into contact with moisture which causes the formation of a loosely adherent powder that may become airborne and produce an exposure by inhalation.

V. DISPOSAL AND SPILLAGE - The disposal of spillage should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instruction of each activity or base.

BERYLLIUM

VI. HANDLING

- A. Avoid skin contact with beryllium salts.
- B. Avoid contact of beryllium metal with open wounds.
- C. Use equipment listed in NAVMAT P-10470

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examination

1. Preplacement - Routine preplacement examination, with special attention to history of previous exposure to beryllium, including residence in vicinity of a plant handling beryllium. Medical history should give special emphasis to respiratory or skin complaints and should include a respiratory questionnaire. Physical examination should include careful examination of the skin and chest and checking for clubbing of fingers. Special tests should include pulmonary function test such as FEV₁ or timed vital capacity, 14" X 17" PA chest film (reviewed by a radiologist), hemoglobin or hematocrit and if there is question of significant previous exposure to beryllium, analysis of urine or tissue for beryllium. (Analysis for beryllium merely confirms exposure, if positive. As yet, correlation has not been established between amount of beryllium in test results and acute or chronic beryllium disease.)

2. Periodic - Routine annual examination, with special attention to respiratory and skin complaints and should include a respiratory questionnaire. Physical examination should include careful examination of skin and respiratory system. Special tests include 14" X 17" PA chest film (reviewed by a radiologist), pulmonary function studies such as FEV₁ or timed vital capacity, hemoglobin or hematocrit, and if there is question of significant exposure, analysis of urine or tissue for beryllium. (see above) Medical records shall be maintained for at least 20 years.

B. Emergency Treatment

1. Inhalation - Inhalation of beryllium dust may cause an acute tracheobronchitis or pneumonitis developing within hours or weeks following exposure. Administration of oxygen is indicated for rapidly developing respiratory distress. In the case of acute tracheobronchitis, if respiratory obstruction is moderately severe, administration of bronchodilators or a cortisone-like substance may give relief

while the patient is being transferred to a hospital.

2. Wounds - Wounds contaminated with beryllium should be debrided carefully to ensure removal of all beryllium.

3. Eye Contact - Flush eyes with copious amounts of water 20 minutes by the clock. Within capabilities, remove beryllium particles. Refer to an ophthalmologist.

VIII. REFERENCE INFORMATION

A. BUMED INSTRUCTION 6260.13A of 12 May 1970 "Health Hazards of Beryllium and Beryllium Compounds"

B. NAVMAT INSTRUCTION 6260.1 of 27 Sept. 1967 "Control of Air Pollution Associated With Beryllium Enriched Propellants"

C. Criteria for a Recommended Standard, "Occupational Exposure to Beryllium" U. S. Dept. of Health, Education and Welfare, Health Services and Mental Health Administration, National Institute for Occupational Safety and Health (1972).

BERYLLIUM

HAZARDS

Beryllium is highly toxic, especially by inhalation of its dust. When heated above 1400°F (760°C), hazardous beryllium fumes result.

EMERGENCY PROCEDURES

1. Eyes - If beryllium powder or chips are splashed in the eyes, do not rub, flush with water for at least 20 minutes. Lift upper and lower eyelids frequently to ensure complete washing. Have someone call Medical immediately.
2. Skin - If beryllium powder or chips come in contact with open wounds in the skin, flush with water for 15 minutes. Report to Medical.
3. Inhalation - If dust from beryllium is inhaled or suspected to have been inhaled, contact Medical immediately.
4. Spills - Evacuate the area, move upwind, wear a U.S. Bureau of Mines approved air supplied respirator or a cartridge respirator supplied with an ultra filter or its equivalent. If practical, wet down the spill with water, cover with sand, a tarp or some other suitable material. Contact the appropriate department.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

2-BUTANONE

SYNONYMS: Methyl Ethyl Ketone - MEK

THRESHOLD LIMIT VALUE (1973)*: 200 ppm or 590 mg/M³

EMERGENCY EXPOSURE LIMIT*: None set

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE:
Unknown, but probably 10,000 ppm or above.

SIGNIFICANT PROPERTIES: MEK is a clear volatile liquid having an odor of acetone.

Chemical Formula	CH ₃ COC ₂ H ₅
Physical State	Liquid at ordinary temperatures and pressures
Explosive Limits	Lower 2% (approx.)
(by volume in air)	Upper 12% (approx.)
Flash Point	-6.6°C (20°F) Tag. closed cup
	-1.1°C (30°F) Tag. open cup
Auto-ignition Temperature	515.5°C (960°F)
Boiling Point	79.6°C (175.2°F)
Color	Clear and colorless
Corrosivity	Noncorrosive
Density, lbs/gal. @ 20°C	6.72
Freezing Point	-86.9°C (-124.4°F)
Heat of Vaporization cal/g	106.0
Molecular Weight	72.10
Odor	Like Acetone
Refractive Index, 20°C	1.3787
Solubility in Water, 20°C	27.1% w
Solubility of Water in Ketone, 20°C	12.5% w
Density @ 20°C	0.8054 g/cc
Vapor Density (air = 1)	2.5
Vapor Pressure 20°C (68°F)	
mm Hg	70.6
Viscosity at 15°C, poise	0.00423
Maximum Saturated Air Concentration (calculated) @ 20° (68°F)	92,800 ppm (272,632 mg/M ³)

USES: Solvent for lacquers, synthetic resins, and synthetic rubber.

* See Appendices A and B for current value

2-BUTANONE

I. PHYSIOLOGICAL HAZARDS - 2-Butanone does not present a serious industrial hazard if the workers are adequately supervised and instructed in the proper means of handling it. Potentially harmful concentrations of vapor give warning of their presence by odor and irritation. The vapor of 2-Butanone is irritating to the mucous membrane of the eyes, nose, and respiratory tract. Liquid 2-Butanone is a powerful degreasing solvent and prolonged or repeated contact with the skin should be avoided.

A. Inhalation and Eye Contact - 2-Butanone is irritating to the mucous membrane of the eye and respiratory tract. At levels around 10,000 ppm almost intolerable irritation of the eyes and nasal passages occurs promptly; headache, nausea, and serious narcosis may develop within a short time.

B. Skin Contact - There is no evidence to indicate that repeated exposure to tolerable concentrations of 2-Butanone will produce any symptoms of chronic toxicity. Repeated or prolonged skin contact causes dryness and irritation of the skin.

II. SPECIAL HAZARDS

A. 2-Butanone is a low flash flammable liquid and its vapors form explosive mixtures with air over a fairly wide range of concentrations.

B. 2-Butanone is quite volatile, and the vapor which is heavier than air may accumulate in low spots or travel along the ground and be ignited by sparks or other flames at locations remote from the handling site.

III. PRECAUTIONS

A. Personal Protection - (See Safety Equipment Manual NAVMAT P-10470 current edition for appropriate protective equipment.)

1. Inhalation - Local exhaust ventilation must be provided for personnel exposed. For short term exposures, respirators must be U.S. Bureau of Mines/NIOSH approved for the specific hazard condition.

2. Skin Contact - Butyl gloves and clothing should be worn.

3. Eye Contact - Chemical safety goggles and/or face shield should be used.

B. Environmental Protection

1. Conduct spraying operations in a properly designed exhaust ventilated booth which is equipped with explosion-proof lights and motors. Provide good general ventilation to control exposures to small quantities of 2-Butanone. Use local exhaust or good general ventilation for drying of sprayed parts during production.

2. Enclosed handling areas (tank rooms, laboratories, etc.) should have fire protection sprinklers and ventilation capabilities of at least six air changes per hour. Fires involving 2-Butanone can be extinguished with CO₂, dry chemical and foam. Water spray is effective for controlling 2-Butanone fires in open containers and water streams should be used for cooling tanks and drums of 2-Butanone in the vicinity of a fire.

IV. STORAGE

1. Store in an area approved by the Safety Department, away from fire hazards and possible sources of heat and oxidizing agents.

2. Ground storage drums or tanks of 2-Butanone to prevent accumulation of static electricity. Ground the receiving container when 2-Butanone is being dispensed

V. DISPOSAL AND SPILLAGE - The disposal of this material should be in accordance with accepted practices as delineated in Disposal Methods and Procedures Instruction of each activity or base.

VI. HANDLING - 2-Butanone should be handled in closed systems and containers whenever possible. Electrical grounding and explosion-proof constructed equipment shall be used. Transfer by pressure or gravity should be avoided; hand or explosion-proof pumps are preferred. Spark-proof tools should be used. No smoking is allowed in any 2-Butanone areas.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examination

1. Preplacement - Routine pre-hire/preplacement examination, with special attention to employment history and previous experience with 2-Butanone, if any. Also of

2-BUTANONE

interest are complaints involving respiratory and digestive systems, headaches and skin problems, as such problems might mimic those of 2-Butanone exposure. If there is question of current significant exposure to ketones, urine or blood may be tested for acetone.

2. Periodic - Routine annual physical examination with special attention to complaints involving respiratory and digestive systems, headaches and skin problems. If significant exposure to 2-Butanone is suspected, urinary or blood acetone may be of value.

B. Emergency Treatment

1. Inhalation - Supply oxygen and ventilatory support as needed. Less severe exposures can generally be managed by removal from exposure and rest. In cases of severe exposure, signs and symptoms of respiratory tract irritation may be present and pneumonitis may develop. Inhalation of 100% oxygen for one hour is useful in the treatment of inhalation exposures to many chemicals, especially those causing immediate or delayed harmful effects to the lungs.

2. Ingestion - Accidental ingestion of significant amounts of 2-Butanone is unlikely. In the event of ingestion, lavage the stomach with warm water. Be prepared to support respiration.

3. Skin Contact - Wash with soap and water to remove any residual 2-Butanone. Adverse effects on skin result from the defatting action of 2-Butanone and require repeated exposures. Be alert, however, for possible narcosis from concomitant inhalation of 2-Butanone vapor. (See above.)

4. Eye Contact - Flush eyes with copious amounts of water for 15 minutes, washing beneath lids. Damage beyond local irritation is not expected from 2-Butanone itself, but other materials dissolved in it might cause damage. Determine, if possible, likely contaminants and, if in doubt, consult an ophthalmologist.

2-BUTANONE

HAZARDS

2-Butanone (MEK) forms explosive mixtures with air and the vapors can be ignited by sparks etc.

EMERGENCY PROCEDURES

1. Fire - In the event of a fire, notify the Fire Department immediately. MEK can be extinguished with water fog, foam, CO₂, or dry chemical.
2. Inhalation - If vapors are inhaled and breathing has slowed down or stopped, remove worker from the exposure and start artificial respiration at once. Have someone call Medical. Do not delay artificial respiration.
3. Eyes - If splashed into the eyes, do not rub them. Flush them with water for at least 15 minutes. Lift the upper and lower eyelids frequently to ensure complete washing and report to Medical.
4. Skin Contact - Flush affected areas immediately with water for at least 15 minutes after removing contaminated clothing. Report to Medical.
5. Ingestion - Call the Medical Department immediately.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY INDUSTRIAL ENVIRONMENTAL HEALTH BULLETIN

CARBON BLACK

SYNONYMS: Carbon black is a broad term encompassing several types of "black" prepared by various methods and processes. The more commonly used types are called channel black, furnace black, and thermal black.

THRESHOLD LIMIT VALUE (1973)*: 3.5 mg/M³

EMERGENCY EXPOSURE LIMIT*: None set

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE:

SIGNIFICANT PROPERTIES: The composition of carbon black varies from 88-99.5% carbon, 0.3-11% oxygen, 0.1-1% hydrogen, up to 1% inorganic materials and small amounts of tarry material and traces of sulfur.

Chemical Formula	C
Atomic Weight	12.01
Specific Gravity	1.8-2.1
Boiling Point	4200°C (7592°F)
Solubility	Insoluble in all solvents
Particle Size	0.001-0.5 microns
Color	Black amorphous powder
Shape	Spherical
Crystal Structure	Similar to that of graphite, but less regular
Surface Area	
Channel Black	90-100 M ² /gram
Furnace Black	18-250 M ² /gram
Forms	Powder, pellets, pastes

USES: Tire treads, belt covers, and other abrasion-resistant rubber products; plastics as reinforcing agents; opacifier; electrical conductivity; UV light absorber; colorant for printing inks; carbon paper; typewriter ribbons; paint pigments; nucleating agent in weather modification.

*See Appendices A and B for current values.

CARBON BLACK

I. PHYSIOLOGICAL HAZARDS - There are no well demonstrated health hazards in the carbon black industry at present. In laboratory studies with small animals, skin contact with carbon black seemed to produce harmful effects and effective adsorption of known carcinogens occurred. Inhalation produced only accumulations of dust in the pulmonary system.

II. SPECIAL HAZARDS - Finely dispersed carbon black dust may be a fire risk and in a confined space carbon monoxide formation is possible from incomplete combustion.

III. PRECAUTIONS

A. Personal Protection - (See Safety Equipment Manual NAVMAT P-10470 July 1969 for appropriate protective equipment.)

1. Inhalation - Local exhaust equipment must be provided for personnel exposed. For short term exposures, respirators may be used. All respirators must be U.S. Bureau of Mines/NIOSH approved for the specific hazardous condition.

2. Skin Contact - Protective clothing should be worn to minimize skin contact. In some factories the workers cover their faces with talcum powder in order to prevent the penetration of carbon black into the skin.

3. Eye Contact - Goggles or other eye protective devices should be worn in dusty atmospheres.

B. Environmental Protection - Water for washing of eyes and skin should be available. Dust control ventilation may also be indicated in some situations.

IV. STORAGE - Being elemental carbon, carbon blacks are generally considered to be chemically inert and are stable materials under ordinary storage conditions.

V. DISPOSAL OF SPILLAGE - The disposal of spillage should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instruction of each activity or base.

VI. HANDLING - Good housekeeping should be practiced to prevent a dusty atmosphere.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS - Adverse effects of human industrial exposure to carbon black have not been reported. The variability of composition, notably "small amounts of tarry material" allows for possible contamination with substances which might have adverse effects.

A. Examination

1. Preplacement - Routine pre-hire/preplacement examination, with special attention to employment history and possible exposure to substances associated with carcinogenesis, as in coke plant or wax press operations. Physical examination should include detailed examinations of the skin and mucous membranes. If history suggests previous exposure to skin carcinogens, it should be noted that scrotal and neck skin were examined and whether there was any evidence of pathology. Routine 14" x 17" PA chest film should be reviewed by radiologist if previous exposure to carcinogens is suspected.

2. Periodic - Routine annual examination, with detailed examination of skin. 14" x 17" PA chest film should be reviewed by radiologist if interval history suggests respiratory pathology.

B. Emergency Treatment - None indicated.

CARBON BLACK

HAZARD

There are no well demonstrated health hazards in the carbon black industry at present.

EMERGENCY PROCEDURES

Eye Contact - Flush eyes with water to remove the particles.

T O B E R E P R I N T E D

A N D P O S T E D

NAVY INDUSTRIAL ENVIRONMENTAL HEALTH BULLETIN

CHLORINE

SYNONYMS: None

THRESHOLD LIMIT VALUE (1973)*: 1.0 ppm (3 mg/M³)

EMERGENCY EXPOSURE LIMIT*: None set

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE:
Unknown for humans, however, the following is known:

Animals: Brief exposures to air containing 1000 ppm (3000 mg/M³) kills even large animals.

Humans: Exposure for 1/2 to 1 hour to concentrations of 14 to 24 ppm (40 to 60 mg/M³) is dangerous, and the concentrations of 100 ppm (290 mg/M³) cannot be borne for longer than 1 minute.

SIGNIFICANT PROPERTIES: Chlorine is a greenish-yellowish gas with a sharp pungent odor. It forms explosive mixtures with hydrogen. Hydrogen and many powdered metals will burn in a chlorine atmosphere. Chlorine is very active and is never found free in nature. Chlorine forms hydrochloric acid in the presence of moisture. Liquid chlorine vaporizes rapidly when exposed to the air.

Chemical Formula	Cl ₂
Molecular Weight	Cl ₂ : 70.914, Cl : 35.457
Boiling Point	-34.5°C (-30.1°F)
Critical Temperature	144°C (291.2°F)
Density (liq.)	1.47 @ 0°C (3.65 atm) (water = 1.00)
Latent Heat of Fusion	22.9 Cal/gm @ -101.5°C 41.2 Btu/lb @ -150.7°F
Latent Heat of Vaporization	68.8 Cal/gm @ -34.05°C 123.8 Btu/lb @ -29.3°F
Melting Point	-103±5°C (-153.4 ±9°F)
Solubility	Water 1.46 gm/100cc @ 0°C Hot water 0.57 gr/100cc @ 30°C Alkaline sol. soluble
Vapor Density	2.49 (Air = 1.00)
Vapor Pressure	4800 mm @ 20°C
Maximum Saturated Air Concentration(calculated) @ 20°C (68°F)	Capable of reaching saturation (18,313,500 mg/M ³)

*See Appendices A and B for current values.

CHLORINE

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Chlorine is an extremely powerful vesicant and respiratory irritant. Low concentrations cause damage to mucous membranes. Greater concentrations cause lung damage and give rise to pulmonary congestion and edema which may lead to anoxia. Repeated exposure to chlorine gas causes rapid loss of ability to detect chlorine odor in small concentrations. In general, continued exposure to low concentrations of chlorine weakens the respiratory systems which may increase the incidence of respiratory diseases.

B. Skin - In high concentrations, chlorine can cause burning, inflammation and/or blister formation.

C. Eyes - Low concentrations of chlorine can cause severe irritation of the eyes. High concentrations can produce burns.

D. Ingestion - Unlikely, but would cause severe burning of tissue and probably result in death. Ingestion of chlorine gas would probably destroy the mucous lining of the mouth and throat.

II. SPECIAL HAZARDS

A. Odor does not provide sufficient warning of an over-exposure. Repeated exposure to chlorine gas causes rapid loss of ability to detect chlorine odor in small concentrations.

B. Chlorine gas is heavier than air and thus can collect in low areas and confined spaces.

III. PRECAUTIONS

A. Personal Protection (See Safety Equipment Manual NAVMAT P-10470 July 1969 for appropriate protective equipment.)

1. Inhalation

(a) Local exhaust ventilation must be provided for all operations where liquid or gaseous chlorine is used.

(b) For short-term emergency situations, use an airline respirator, self-contained breathing equipment, gas mask or cartridge filter respirator utilizing cartridges of activated carbon and soda lime combination or impregnated carbon. All respiratory protective equipment should bear a U.S. Bureau of Mines/NIOSH approval for the exposure of concern and type used should be chosen with regard to use location and availability of sufficient oxygen.

CHLORINE

2. Skin Contact - Impervious clothing fabricated from or impregnated with polyvinyl alcohol should be provided when there is any possibility of contact.

3. Eye Contact - Chemical worker's goggles should be worn where there is a chance of exposure to either the liquid or gas.

4. Ingestion - No food, drink, or tobacco should be allowed in areas where chlorine is being used. Hands and face should be washed before eating, drinking and/or smoking.

B. Environmental Protection

1. Local and/or general room ventilation should be provided to ensure the atmospheric concentration of chlorine vapor does not exceed 1 ppm by volume. The location of exhaust inlets should be as close as possible to the point of generation.

2. The exhaust vapors should be released outside and above the roofline to prevent possible re-entry of the gas into adjacent occupied areas

3. Provide showers and eyewash fountains in areas where chlorine exposures may occur.

IV. STORAGE - All containers, empty or full, should be stored in cool, dry areas away from external heat sources or direct sunlight. Storage areas should be well ventilated. Laboratory operations requiring chlorine liquid or gas are to be performed in chemical hoods.

V. DISPOSAL - The disposal of this material should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instruction of each activity or base.

VI. HANDLING - When handling this hazardous gas, extreme precautions should be taken, and in addition, the equipment and clothing described in the Safety Equipment Manual, NAVMAT P-10470 July 1969 should be used.

CHLORINE

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examination

1. Preplacement - Routine pre-hire/preplacement examination with special attention to employment history, skin and cardiorespiratory complaints and previous reactions to chlorides. Special tests include 14" x 17" PA chest film reviewed by a radiologist, standard 12 lead EKG and pulmonary function studies such as FEV₁ or timed vital capacity.

2. Periodic - Routine annual examination unless complaints of upper respiratory irritation or other cardiorespiratory problems indicate earlier evaluation. In reviewing the interval history, special attention should be given to skin and respiratory complaints. Special tests include 14" x 17" PA chest film reviewed by a radiologist, standard 12 lead EKG and pulmonary function studies such as FEV₁ or timed vital capacity.

B. Emergency Treatment

1. Inhalation - Keep in sitting position, propped up if necessary. Administer oxygen and supply ventilatory support. Airway may be endangered by burns of nasal and oropharyngeal mucosa, glottic or laryngeal edema. Tracheotomy may be required. Provision must be made for escape of material coughed up or vomited. Tracheotomy, if done, may require clearing by suction. Mucosal edema or pulmonary edema may be arrested by injection of a cortisone-like material such as dexamethasone 4 mg. I.M. or I.V. stat.. If pulmonary edema is not controlled by injection of steroid, injection of a rapid-acting mercurial diuretic such as merialuride may be of value. Pulmonary edema may occur after a latent period of many hours, and since tracheobronchitis and/or pneumonia may follow, admission to a hospital for observation and/or treatment is advised.

2. Skin Contact - Remove and dispose of contaminated clothing expeditiously. Wash with soap and water to remove any residual chlorine or hydrochloric acid. Litmus or pH indicator paper may help assess effectiveness of removal. Dilute sodium bicarbonate solution or a thin paste of sodium bicarbonate may be used if further neutralization of skin is required. When decontamination is completed, treat as equivalent thermal burns. Take precautions for concomitant inhalation of chlorine. (See above.)

3. Eye Contact - Eye irritation resulting from exposure to relatively low concentrations of chlorine may respond to removal from exposure and symptomatic treatment. Exposure to

CHLORINE

heavier concentrations can cause severe burns. Flush the eyes with copious quantities of water for 15 minutes, washing under the lids. A local anesthetic such as pro-paracaine hydrochloride may be needed to overcome lid spasm. When flushing is complete, patch both eyes. Since the probability of concurrent inhalation of chlorine is high, admission to a hospital for observation and/or treatment of respiratory complications is advised. Emergency ophthalmology consultation is recommended.

NOTE: The boiling point and reactivity of chlorine are incompatible with ingestion of chlorine as such.

CHLORINE

HAZARDS

Chlorine gas is irritating to the mucous membranes and skin. Liquid chlorine will cause skin and eye burns which are slow to heal.

EMERGENCY PROCEDURES

1. Inhalation - Immediately remove the victim from the contaminated area. Call Medical Department.
2. Skin Contact - Remove all contaminated clothing and wash the affected area immediately with soap and water for 15 minutes. Report to Medical Department.
3. Eye Contact - DO NOT RUB. Irrigate immediately with water for 15 minutes holding lids apart to ensure water contact with eye and lid surfaces. Notify and report to Medical Department.
4. Ingestion - Contact Medical Department.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

ETHYL ETHER

SYNONYMS: Ether, Diethyl Ether, Diethyl oxide, Ethyl oxide, Ethoxyethane

THRESHOLD LIMIT VALUE (1973):* 400 ppm (1200 mg/M³)

EMERGENCY EXPOSURE LIMIT:* None set

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE (1966): 100,000 ppm or 10% concentration

SIGNIFICANT PROPERTIES: Ethyl ether is a clear, highly volatile, extremely flammable liquid with a characteristic sweetish pungent odor. It can form explosive peroxides on standing in air, especially in sunlight.

Chemical Formula	CH ₃ CH ₂ OCH ₂ CH ₃
Molecular Weight	74.12
Specific Gravity	0.708 (Water - 1.00)
Flash Point	-45°C (-50°F)
Boiling Point	34.6°C (94°F)
Solubility	7.5 gm/100 ml water at 20°C; completely soluble in alcohols, benzene, chloroform, fat solvents, and oils
Vapor Pressure	537.0 mmHg at 25°C (77°F)
Maximum Saturated Air Concentration (calculated) at 25°C (77°F)	706,579 ppm (2,140,934.37 mg/M ³)

USES: It is used primarily as a solvent in industry particularly for many organic materials such as oils, dyes, resins, nitrocellulose, hydrocarbons and raw rubber. It is also used as an extraction medium in the chemical industry and the analytical laboratory. Additionally, it is used as an inhalation anesthetic.

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - This compound is readily absorbed through the lungs and up to 90% is eliminated in the expired air. The most common effect as a result of inhalation is general anesthesia. Acute overexposure to high

* See Appendices A and B for current values

ETHYL ETHER

levels initially results in vomiting, lowering of pulse rate, lowered body temperature and irregular breathing. Cases of narcosis in industry as a result of ether inhalation are not uncommon.

B. Skin Contact - Contact of short duration has no ill effect. Ether is a mild irritant. Repeated exposure can cause skin defatting evidenced by drying and cracking.

C. Eye Contact - Ether is irritating to the eye as a vapor in the air or as a liquid. Undiluted ether will cause painful inflammation of the eye upon direct contact. Damage is not usually permanent.

D. Ingestion - Ether has an irritating effect on mucous membranes and oral consumption is to be avoided. Ether habit by ingestion has been reported and the symptoms are similar to those of chronic alcoholism, although the symptoms occur earlier.

II. SPECIAL HAZARDS

A. One of the most significant hazards is that of fire and explosion. It has a wide explosive range of 1.9% to 48.0% by volume in air and a flash point of -50°F.

B. Ethyl ether is not a highly poisonous substance, however, its vapors can produce anesthesia, narcosis and intoxication.

C. Due to its high vapor pressure at ambient (room) temperatures, this material can readily reach excessive concentrations which could have a narcotic effect on personnel in addition to presenting a serious fire hazard.

III. PRECAUTIONS

A. Personal Protection (See Safety Equipment Manual NAVMAT P-10470 latest edition for appropriate protective equipment).

1. Inhalation - Local exhaust ventilation to control vapors at the source should be provided. Explosion-proof ventilation equipment may be required. Contact the Safety Department for appropriate equipment and specifications for ether ventilation. In some cases, good general room ventilation is adequate. Handling procedures should seek to enclose the ether liquid as much as possible. The nature of ethyl ether is such that

chemical cartridge respirators or gas masks should not be used. A supplied air respirator and lifeline should be used for tank entry and may also be used in atmospheres not immediately harmful to life. A full face self-contained breathing apparatus should be used in case of spills. All respirators should be approved by the National Institute of Occupational Safety and Health/U.S. Bureau of Mines for the appropriate exposure of concern.

2. Skin Contact - Continuous skin contact with the liquid should be prevented by the use of neoprene, Buna-N or butyl rubber gloves. Natural rubber and some materials will swell and/or deteriorate after a time and should be discarded. Other articles of clothing wet with ether should be removed and not worn until dry.

3. Eye Contact - In cases where eye contact is possible chemical goggles or a face shield should be provided. Flush the eyes with water in cases of eye contact.

4. Ingestion - While unlikely, if swallowed, the individual should be removed to fresh air and emetics administered. A physician should be called immediately. Eating, drinking, or smoking should be prohibited in areas where ether is used.

B. Environmental Protection

1. Ether should never be used where adequate ventilation is not present. In some cases where the quantity used is high and the application indicates that excessive personnel exposures are likely, local exhaust ventilation to control vapors at the point of generation is recommended.

2. Eye wash fountains and showers should be available in areas where ether is handled.

IV. STORAGE

A. Ethyl ether is classified as a flammable liquid and Interstate Commerce Regulations are applicable to shipping and to the containers used. Electrical equipment including lighting and storage rooms, buildings, cabinets or tanks where ethyl ether is stored should comply with the standards of the National Fire Protection Association for flammable liquids, gases and chemicals.

B. Containers of ethyl ether should be kept in unheated compartments away from sunlight and ignition sources.

ETHYL ETHER

Containers should be isolated from other chemicals and protected from mechanical injury.

V. DISPOSAL AND SPILLAGE

A. Spillage of ethyl ether generally necessitates the donning of self-contained breathing apparatus.

B. Disposal of large quantities of ethyl ether should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instruction of each activity.

VI. HANDLING

A. Ethyl ether liquid should be confined and fire protection devices provided. All sources of ignition, friction and static discharges should be removed from handling areas. Preparations containing ether should be heated or distilled only over a low pressure steam bath or hot water bath without an exposed heating element. Ether should only be evaporated under conditions of good ventilation.

B. Smoking, of course, should be prohibited where ether is used, handled or stored. Signs should be displayed calling attention to the hazards of inhalation and fire.

C. The recommended extinguishing agents for fires involving ethyl ether are carbon dioxide and dry compound extinguishers. Sand is effective for small fires.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - The usual preplacement evaluation should suffice. Some recommend that those with chronic bronchitis or chronic kidney disease be excluded from exposure.

2. Periodic - No special determinations are recommended.

B. Emergency Procedures

1. Inhalation - As an anesthetic, narcosis and unconsciousness through the usual stages of anesthesia are produced. A few reports of symptoms at the excitatory stage have been reported. Such an individual should be excluded from further exposure. Unconsciousness or respiratory arrest should receive the usual supportive therapy. Some cases may result in aspiration with subsequent pneumonia; this should be guarded against.

2. Ingestion - This is rare because of the irritating effect. Other than unconsciousness adverse effects, except for possible aspiration, are rare. "Ether jags" alone or with alcohol are also rare.

ETHYL ETHER

HAZARD

Ethyl ether is not a highly toxic substance, however, it can produce anesthesia and intoxication when present in sufficient concentrations. Perhaps the greatest hazard of ethyl ether is fire and explosion. The liquid and the vapor of ethyl ether pose such a hazard.

EMERGENCY PROCEDURE

1. Inhalation - Remove the inhalation victim to fresh air. An unconscious victim whose breathing has been slowed or stopped should be given artificial respiration and oxygen if available. A physician should be called.
2. Eyes - Flush the eyes, especially under the lids, with water for at least 15 minutes. Consult a physician.
3. Skin - Remove contaminated clothing and flush with water.
4. Spills - Large spills require area evacuation and in some cases the donning of self-contained breathing apparatus will be necessary to facilitate evacuation and/or clean-up. Ventilate the area at a high rate.
5. Ingestion - Remove the individual to fresh air and induce vomiting. A stimulant such as coffee may be given if victim is conscious. A physician must be called immediately.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY INDUSTRIAL ENVIRONMENTAL HEALTH BULLETIN

HYDRAZINE

SYNONYMS: Hydrazine base, anhydrous hydrazine, diamine

THRESHOLD LIMIT VALUE (1973)*: 1.0 ppm (1.3 mg/M³) Skin

EMERGENCY EXPOSURE LIMIT (1968)*:
30 ppm for 10 min
20 ppm for 30 min
10 ppm for 60 min

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE:
Unknown for humans. Rats given 100 ppm for 1/2 hour resulted in mortality from pulmonary edema before 14 days.

SIGNIFICANT PROPERTIES: Colorless oily liquid @ 20°C or white crystals @ 0°C; odor of ammonia.

Chemical Formula	N ₂ H ₄
Molecular Weight	32.05
Boiling Point	113.5°C (236.3°F)
Melting Point	1.4°C (35°F)
Vapor Pressure @ 20°C	10.4 mmHg
Density @ 15°C	1.011 g/cc
Density of Vapor	1.11 (Air = 1)
Refractive Index	1.470 ²²
Flash Point	52.2°C (125.6°F) open cup
Autoignition Temperature	270°C (518°F)
Viscosity @ 20°C (68°F)	0.97 centipoises
Critical Temp.	380°C (716°F)
Critical Pressure	145.1 atm (110,250 mmHg)
Maximum Saturated Air Concentration (calculated) @ 20°C (68°F)	13,684 ppm, (17,789 mg/M ³)

USES:

1. Rocket propellant
2. Salts are used as fluxes in soft and aluminum soldering

*See Appendices A and B for current values.

HYDRAZINE

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - If inhaled, the vapor of hydrazine causes local irritation of eyes and respiratory tract, and systemic effects. On short exposures, systemic effects involve the central nervous system. Resultant symptoms, which may be delayed, include tremors. On exposure to higher concentrations, convulsions and possibly death follow. Chronic exposures may cause damage to the liver and kidney as well as anemia.

B. Skin Contact - Hydrazine is absorbed through the skin which results in the same effects as inhalation. Hydrazine and hydrazine vapors produce dermatitis. Both are highly irritating and have a severely corrosive effect on the skin. Necrosis of the skin may be caused when contacted by both vapor and liquid.

C. Eye Contact - Hydrazine and its vapors in contact with the eyes may cause blindness.

D. Ingestion - The symptoms and reactions for ingestion are the same but more severe than those of skin contact and inhalation, and may prove fatal.

II. SPECIAL HAZARDS

A. Odor may not provide adequate warning of harmful concentrations.

B. Fires may be started upon contact of hydrazine with oxidizing materials such as peroxides and chromic acid, and metallic oxides such as mercuric oxide, lead oxide, manganese dioxide, molybdenum oxide, and iron oxide.

C. Hydrazine vapor will burn in all concentrations above 4.7% by volume in air.

D. Hydrazine vapor can be exploded by an electric spark or open flame.

E. Hydrazine will burn in the absence of air or an oxidizer.

F. Liquid hydrazine is not sensitive to shock or friction.

G. Rags, cotton waste, saw dust or other materials of a large surface area that have absorbed hydrazine may eventually cause spontaneous ignition.

H. Hydrazine is an explosive hazard.

III. PRECAUTIONS

A. Personal Protection - See Safety Equipment Manual NAVMAT P-10470, July 1969 for appropriate protective equipment.

1. Inhalation - Approved respiratory protection shall be worn whenever it is necessary to work continuously in an atmosphere in which the vapor concentration of hydrazine exceeds the TLV or EEL. The presence or absence of an odor is not a reliable indication of the need for wearing respiratory protective devices. In confined spaces and where moderate or high concentration of vapors may be present, it is recommended that a self-contained protective breathing apparatus always be used. The "Buddy System" shall be used on all transferring, handling, testing and storage operations.

2. Skin Contact - Fuel and oxidizer protective gloves covered by Military Specification MIL-G-43196A (FSC 8415) shall be worn. Natural rubber, reclaimed rubber, or GR-S rubber safety shoes, or an overboot designed to be worn over regular safety footwear and high enough to fit comfortably under the legs of protective trousers, shall be worn. Contaminating agents shall be removed promptly, and the footwear shall be inspected frequently. Under normal conditions, rubber or plastic wrist and arm protectors, and a rubber apron or equivalent shall be worn. Whenever there is a possibility of gross splashing, protective clothing covered by Military Specification MIL-C-43063B (FSC 8415) shall be worn. Also recommended are rubber or rubberized items of clothing (neoprene), fiberglass clothing impregnated with a fluorocarbon resin, and vinyl-coated cotton. Copious water flushing is recommended for personnel decontamination.

3. Eye Contact - A plastic face shield along with safety goggles shall be worn.

4. Ingestion - A plastic face shield should be worn to prevent any ingestion of spilled or splashed hydrazine.

HYDRAZINE

B. Environmental Protection

1. Closed or confined areas must have good ventilation. If natural ventilation is inadequate, a mechanical exhaust ventilation system should be provided. A forced-draft ventilating system should be so arranged that a fire in the area will automatically cause shut-down. There should be remote manual controls for the ventilation system. In enclosed spaces all personnel must be evacuated when the concentration of hydrazine in the atmosphere reaches 20 percent of the lower explosive limit, i.e., 0.94% by volume.

2. All hydrazine storage and transfer areas, as well as surrounding areas that may be reached by leakage or spills, should be cleared and kept clean of organic matter and oxidizers. Frequent inspections should be made to ensure the continuation of good housekeeping.

3. If fire breaks out, water which acts by cooling and diluting, is the most effective agent for completely extinguishing air-supported hydrazine fires. The most efficient means of applying water is in a coarse spray. Water-fog and bicarbonate-base extinguishing agents may be used for combating spill-type fires. In large fires, there is a danger of flash-backs with these agents, however, effective use of water minimizes the re-ignition and flash-back hazard. Halogenated firefighting agents (carbon tetrachloride) are generally ineffective on this type of fire.

4. For oxidizer-supported fires, water fog is the most effective extinguishing agent if it is acceptable for use on the specific oxidizer feeding the fire.

IV. STORAGE

A. Good practice in storage requires that temperatures be held below 120°F (49°C). Strong oxidizing agents should be kept out of the immediate storage area. The storage area should be equipped with good drainage facilities. If hydrazine is stored in tanks, they shall be surrounded by a dike of sufficient height to hold 10% over maximum storage capacity of the tank.

B. Do not store hydrazine where it may contact the following materials, otherwise fire will result: stainless steels containing more than 0.50% molybdenum, cast alloys,

40E aluminum, Monel, magnesium, zinc, lead, cadmium, copper and its alloys, and iron. Provide all storage areas, unless grounded, with adequate protection from lightning by use of lightning arrestors. Storage areas should be fitted with the appropriate fire fighting equipment and this equipment should be inspected periodically for proper functioning. It is permissible to store hydrazine in the same area with mono-ethylaniline, aniline, anhydrous ammonia, and hydrazine hydrate. Adequate ventilation facilities must be present in the storage area.

V. DISPOSAL AND SPILLAGE - All leaks and spills should be immediately flushed away with copious quantities of water. Dilution should be a minimum of ten to one. During the disposal process, the worker should be suitably clothed and protected at all times. After dilution, small quantities and dilute solutions can be collected in a basin and reacted with compounds such as 10% hydrogen peroxide (H_2O_2) or calcium hypochlorite [$Ca(ClO)_2$]. Neutralizing agents such as acetic acid (HCO_2CH_3) should be applied in excess. The disposal of these materials should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instructions of each activity.

VI. HANDLING - Wear prescribed protective clothing as listed in NAVMAT P-10470 of July 1969. Use the "Buddy System" in all handling procedures. Do not handle hydrazine near oxidizing materials. Do not expose to combustible materials. Keep away from heat, fires or sparks. Do not smoke within 100 feet of hydrazine handling operations. Food is not allowed in an area where hydrazine is being handled. Provide running water supplies in the handling area in the form of an eye wash fountain, a safety shower, fire extinguishers and adequate decontamination and flushing hoses. Handle hydrazine in areas where spillage will not come in contact with organic matter or rust.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examination

1. Preplacement - Routine preplacement examination, with special attention to skin, and medical history

HYDRAZINE

as to allergies and possible previous reactions to hydrazine. History of liver, kidney or respiratory disease should be followed-up by appropriate tests. History of convulsions or central nervous system complaints should be followed-up by detailed history from attending physician and neurological work-up as indicated. Special tests should include timed vital capacity and liver battery, hemoglobin or hematocrit, as well as routine urinalysis including microscopic exam.

2. Periodic - Routine annual examination with special attention to skin is recommended. The abdomen should be palpated for evidence of liver enlargement or right upper quadrant tenderness. Neurological examination should include reflexes, balance and checking for tremors. Interval history should include questions as to skin problems, gastrointestinal or respiratory complaints, nervous symptoms such as anxiety, insomnia, irritability or tremors. Weight change should be investigated as to cause. Special tests should include timed vital capacity, liver battery, hemoglobin or hematocrit, routine urinalysis including microscopic examination.

B. Emergency Treatment

1. Inhalation - Provide respiratory support and oxygen if there is respiratory distress. Observe for evidence of respiratory obstruction due to developing laryngeal or epiglottic edema and for possible development of pulmonary edema after a latent period of several hours if there was concomitant inhalation of oxides of nitrogen. Control convulsions or CNS excitement with sedation such as barbiturates. Follow up with observation for possible liver or kidney damage.

2. Ingestion - Administer milk or egg whites if conscious, and follow with mild emetic such as 5% saline. If gastric lavage is attempted, be prepared to manage possible convulsions by injection of sedative such as sodium phenobarbital. Observe for possible liver or kidney damage.

3. Eye Contact - Flush eyes with copious amounts of water for 20 minutes by the clock if general condition does not preclude. Patch eyes and refer to ophthalmologist.

4. Skin Contact - Flush thoroughly with water until all hydrazine has been removed, then manage burns as equivalent thermal burns. Since hydrazine is readily absorbed through the skin, be prepared to manage CNS excitation or convulsions by sedation, such as barbiturates. Observe for possible liver or kidney damage.

HYDRAZINE

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HAZARD

Odor may not provide adequate warning of harmful concentrations. Odor threshold is much higher than the Threshold Limit Value.

EMERGENCY PROCEDURES

1. Inhalation - Move the victim to fresh air immediately if he suffers from irritating effects or has headaches. Contact a Medical Officer.
2. Eyes - Flush with water for at least 20 minutes. Lift upper and lower eyelids frequently to ensure complete washing. Have victim report to Medical.
3. Skin - If splashed on clothing or large area of the body, remove clothing rapidly and wash under a shower for at least 15 minutes with soap. Decontaminate clothing before reuse.
4. Ingestion - If swallowed, cause vomiting by placing finger in back of victim's throat. Contact Medical Officer immediately.
5. Area Spills - In case of a small spill, dilute with water and react with hydrogen peroxide (10%) or calcium hypochlorite. Follow with neutralization by adding acetic acid.
6. Fire - Extinguish fires of hydrazine with large quantities of water, preferably applied as a coarse water spray. After extinguished, treat as a spill.

T O B E R E P R I N T E D

A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

HYDROGEN CHLORIDE

SYNONYMS: None. This bulletin applies to the following: Hydrochloric Acid Mist, Muriatic Acid, Hydrochloric Acid, Anhydrous Hydrochloric Acid, and Aqueous Hydrochloric Acid

THRESHOLD LIMIT VALUE (1973)*: 5.0 ppm (7 mg/M³) "C"

EMERGENCY EXPOSURE LIMIT (1969)*: 30 ppm for 10 minutes
20 ppm for 30 minutes
10 ppm for 60 minutes

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE (1970):
1000 - 2000 ppm

SIGNIFICANT PROPERTIES: Hydrogen chloride is a colorless gas exhibiting white mist in moist air. The aqueous solution is colorless to slightly yellow. Both forms have a sharp, pungent, irritating odor.

Chemical Formula	HCL
Molecular Weight	36.5
Boiling Point	Gas = -85.0°C (-121°F) Aqueous (20-24% HCl)=110°C(230°F)
Freezing Point	Gas = -114.8°C(-175°F) Aqueous = -42°C(-43.6°F)
Vapor Density (Air = 1.0)	1.26 @ 20°C (68°F)
Solubility	82.3 gm/100ml of H ₂ O @ 0°C(32°)
Specific Gravity	1.21 @ 43.4% HCl
Vapor Pressure	31,026 mm Hg @ 20°C (68°F)
Maximum Saturated Air Concentration (calculated) @ 20°C (68°F)	(anhydrous) capable of saturation 60,850,000.0 mg/M ³

USES: Hydrochloric acid is used as a chemical intermediate; in ore reduction; food processing; pickling and metal cleaning; industrial acidizing and general cleaning.

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Hydrogen chloride is a strong irritant causing severe irritation of the upper respiratory tract. Produces burning of the upper respiratory tract and choking sensation. Occasional ulceration of the nose, throat and larynx has been reported. Edema of the lungs may occur.

*See Appendices A and B for current values

HYDROGEN CHLORIDE

B. Skin Contact - Aqueous solutions can cause severe burns, repeated contact with dilute solutions can cause dermatitis.

C. Eye Contact - Rapidly causes severe irritation in either gas or aqueous forms. Failure to remove hydrochloric acid quickly by washing with water will result in prolonged or permanent visual impairment or total loss of sight.

D. Ingestion - HCl is corrosive to tissues, death can result.

II. SPECIAL HAZARDS

A. HCl reacts with metals to produce explosive hydrogen gas.

B. Add acid to water never the reverse.

III. PRECAUTIONS

A. Personal Protection (See Safety Equipment Manual NAVMAT P-10470 current edition for appropriate protective equipment).

1. Inhalation - Local exhaust ventilation must be provided for exposed personnel. For short term emergencies respirators may be used. All respirators must be U.S. Bureau of Mines/NIOSH approved for the specific hazards of concern.

2. Skin Contact - Protective gloves, boots and aprons should be worn when handling hydrochloric acid. Protective equipment composed of or impregnated with neoprene or Buna-N will provide adequate protection.

3. Eye Contact - Chemical workers' goggles or face shields should be worn where splashes are likely to occur.

4. Ingestion - Unlikely, but if it occurs immediate consumption of lime water or milk of magnesia is indicated.

B. Environmental Protection

1. Provide ventilation where hydrochloric acid is being used.

2. Provide showers, eye wash fountains, and water hose in areas where hydrochloric acid exposure or spills may occur.

3. Hydrogen chloride gas should only be used in a closed system.

4. Provide ventilation where hydrogen chloride gas is likely to be evolved through industrial processes, spraying, heating or agitation. Periodic checks of the ventilation system should be made due to the corrosive nature of this acid gas.

5. Ventilation materials composed of fiber glass and PVC have shown great resistance to degradation from HCl.

IV. STORAGE - Hydrochloric acid is strongly corrosive to metals liberating explosive hydrogen gas. It should never be stored in metal containers or allowed to come into contact with metals. Store in glass or glass lined containers in a closed area away from sources of heat.

V. DISPOSAL - The disposal of this material should be in accordance with accepted practices as delineated in the Disposal Method and Procedures Instruction of each activity or base.

VI. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - Individuals with monocular vision, seriously impaired uncorrected vision, or chronic skin or lung disorders should not work with hydrochloric acid, Contact lenses are not acceptable.

2. Periodic - No special recommendations.

B. Toxic Effects - Severe burns of the eye or skin may result from exposure. Copious, **thorough** lavage is mandatory. Ingestion similarly may result in burns, and prompt dilution by intake of large amounts of water, lime water, or milk of magnesia is required. Inhalation - Severe irritation may result in unconsciousness and pulmonary edema.

C. Emergency Treatment - No special treatment is available. Artificial respiration and/or oxygen may be necessary as well as usual measures for treatment of pulmonary edema.

HYDROGEN CHLORIDE

HAZARDS

Hydrochloric acid or hydrogen chloride gas may cause severe irritation or burns of the eyes, nose, and throat as well as of the skin. Ingestion may result in death.

EMERGENCY PROCEDURES

1. Eyes - If hydrochloric acid is splashed into the eyes, immediately flush the eyes with water for at least 15 minutes. Obtain immediate medical attention or report to Medical as soon as possible.
2. Skin - If splashed on the skin, immediately wash with copious quantities of water until all hydrochloric acid is removed. Do not attempt to neutralize the acid with alkaline solutions. Report to Medical.
3. Inhalation - Remove victim from exposure immediately. If unconscious, give artificial respiration. Have someone call Medical.
4. Clothing - Remove contaminated clothing immediately. Wash body with soap and water for 15 minutes. Report to Medical.
5. Ingestion - Do not induce vomiting. Secure medical aid. Report to Medical.
6. Spills - Neutralize spills of concentrated hydrochloric acid with lime or bicarbonate then flood with water. If large spillage occurs, call Safety Department.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

METHYL ALCOHOL*

SYNONYMS: Methanol, Methyl Hydroxide, Methyl Hydrate, Columbian Spirits, Wood Naphtha, Wood Spirits, Sterno, Carbinol, Colonial Spirits.

THRESHOLD LIMIT VALUE (1973)**: 200 ppm (260 mg/M³)

EMERGENCY EXPOSURE LIMIT (1966)**: 1,000 ppm for 60 min.

ATMOSPHERIC CONCENTRATIONS IMMEDIATELY HAZARDOUS TO LIFE:
Unknown

SIGNIFICANT PROPERTIES: Pure methyl alcohol is a clear, colorless, volatile, hygroscopic liquid with a faint odor resembling that of ethyl alcohol. Impure forms may have a disagreeable pungent odor.

Chemical Formula	CH ₃ OH
Molecular Weight	32.04
Boiling Point	148°F (64.5°C)
Explosive Limits - % by volume in air	Lower: 7.3 Upper: 36.0
Flash Point	61°F (16°C) (open cup)
Freezing Point	-144°F (-97.6°C)
Heat of Vaporization	284.3 K Cal/mole
Solidification Point	-144°F (-97.6°C)
Solubility	In water - infinite In ether - infinite In alcohol - infinite
Specific Gravity (Water - 1.00)	Liquid 0.792 Pure Vapor 1.11 Vapor-air mixture 1.02 (@ saturation) 1.006 (@ Lower Explosive Limit) 1.000 (@ Threshold Limit Value)
Vapor Pressure	92 mm @ 68°F (20°C) 159 mm @ 86°F (30°C)
Viscosity (in millipoises)	8.08 (@ 0°C) 5.93 (@ 20°C)
Maximum Saturated Air Concentration (calculated @ 68°F (20 °C))	121,000 ppm (1,673,000 mg/M ³)

* See also BUMEDINST 6200.4A

** See Appendices A and B for current values

METHYL ALCOHOL

USES: Methyl alcohol is an organic solvent used in a wide variety of cleaning and chemical formulations and as "canned heat" and antifreeze. Its use in the Navy is restricted to Laboratories.*

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Inhalation of vapors can cause irritation, headache, fatigue, and drowsiness. Subacute methyl alcohol poisoning may result from prolonged or repeated work in an atmosphere containing concentrations of more than 200 parts per million of methyl alcohol vapor. If such exposures are repeated, the individual may develop poisoning due to the accumulation of methyl alcohol in his system.

B. Skin Contact - Methyl alcohol may be absorbed through the skin in sufficient quantity to cause the same general effects as when inhaled as a vapor. Repeated or prolonged skin contact may result in dermatitis.

C. Ingestion - Symptoms of depression, weakness, headache, nausea, abdominal pain, shortness of breath, delirium or stupor and cold sweat usually develop. A large percentage of cases become blind if not treated promptly. One or two ounces has proved fatal in a number of cases.

D. Eye Contact - Contact of methyl alcohol with the eyes produces lacrimation and burning. The most serious effect on the eyes is blindness produced by absorption into the blood stream through the skin, respiratory system or gastrointestinal tract.

II. SPECIAL HAZARDS

A. Methyl alcohol vapor is denser than air and will accumulate in low lying areas.

B. Methyl alcohol presents a potential fire hazard.

III. PRECAUTIONS

If practicable, add to methyl alcohol an ingredient such as ethyl mercaptan, or kerosene to impart a disagreeable odor and taste. The addition of kerosene in the amount of one-half percent will not alter the properties of methyl alcohol as a cleaner, a paint thinner, or an antifreeze.

A. Personal Protection (See current edition of Safety Equipment Manual NAVMAT P-10470 for appropriate protective equipment).

1. Inhalation

a. Local exhaust ventilation must be provided.

b. For short term emergency situations, airline respirators, self-contained breathing equipment or gas masks designed to protect against organic vapors may be used. All respiratory protective equipment should be approved by the U. S. Bureau of Mines/NIOSH for the particular exposure(s) of concern.

2. Skin Contact - Impervious clothing fabricated from, or impregnated with, the polyvinyl alcohol plastics, neoprene or rubber should be provided when there is any possibility of contact.

3. Eye Contact - Acid type goggles or face-shield should be worn where there is danger of splashing.

4. Ingestion - Wash hands before eating or smoking.

B. Environmental Protection

1. Local and/or general room ventilation should be provided to insure that the atmospheric concentration of methyl alcohol vapor does not exceed 200 ppm by volume. The location of exhaust inlets should be as close as possible to the point of vapor generation.

2. The exhaust vapors must be released outside the building and the point of discharge located so as to prevent possible re-entry of the vapor into adjacent occupied areas.

3. Provide showers and eye wash fountains in areas where methyl alcohol exposures may occur.

IV. STORAGE

Store in a Fire Unit approved storage area away from fire hazards, oxidizing agents, and possible sources of heat.

A. Store in cool, well ventilated areas away from possible sources of heat, fire or sparks. The Safety Department must approve the storage area.

B. Storage drums or tanks of methyl alcohol should be grounded to prevent the accumulation of static electricity. When this material is dispensed, the receiving container should also be grounded. The groundings must be of a type approved by the Safety Department.

METHYL ALCOHOL

C. Drums should be stored out of direct rays of the sun with the plugs upward.

V. DISPOSAL - The disposal of this material should be in accordance with accepted practices as delineated in Disposal Methods and Procedures Instruction of each activity or base.

VI. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - Persons with greatly impaired visual acuity or those with central nervous system disease should not be exposed to methyl alcohol.

2. Periodic - No special procedures are recommended. Careful comparison of visual changes from previous examination is suggested.

B. Poisoning - Local contact may cause drying of the skin and cracking. Systemic effects result from inhalation or through percutaneous absorption.

Acute Poisoning - Can be categorized in three degrees:

Mild - Fatigue, headache, nausea, and after a latent period of 12-24 hours, blurring of vision and dilated pupils.

Moderate - Severe headache, dizziness, vomiting, CNS depression.

Severe - The above plus rapid, shallow respiration, acidosis, shock and coma.

Chronic Poisoning - Is marked by visual impairment, blurring of vision and contraction of visual fields.

C. Treatment - Gastric lavage is useful up to two hours after ingestion.

Acidosis is the most serious problem and a CO_2 combining power below 20 mEq./L indicates severe poisoning in that from 25-50% of these patients do not recover. It has been suggested that 4 gm sodium bicarbonate by mouth (or stomach tube if necessary) be given every 15 minutes until the urine becomes alkaline or the CO_2 combining power

nears normal. (Lactate is not recommended because its metabolism in these patients may be impaired.)

Ethyl alcohol has been recommended to block the metabolism of methyl alcohol and allow for its excretion. An initial dose of 0.75 ml./kg followed by 0.5 ml./kg. every four hours for four days has been used.

Supportive therapy should be given as indicated. Relapses are common.

VII. REFERENCE INFORMATION

The following reference(s) is/are germane to this Environmental Health Bulletin:

A. BUMED INSTRUCTION 6200.4A of 26 May 1970 "Hazards of Methyl alcohol"

METHYL ALCOHOL

HAZARDS

HEALTH HAZARDS - Methyl alcohol is toxic by ingestion, vapor inhalation, and absorption through the skin. Ingestion can result in blindness and death. It is a depressant and is irritating to the mucous membranes. It has additional toxic effects, related to substances resulting from its metabolism in the body and its relatively slow rate of elimination. Contact lenses shall not be worn when working with methyl alcohol.

FIRE HAZARD - Methyl alcohol is volatile and flammable. It is a serious fire and explosive hazard when used in the open atmosphere. Extinguish fires with carbon dioxide, foam or dry chemical, and keep a fire blanket at hand for personnel protection.

EMERGENCY PROCEDURES

1. Vapor Inhalation - Immediately remove the victim from the contaminated atmosphere. Call Medical as quickly as possible.
2. Eye Contact - DO NOT RUB: Immediately irrigate the eyes with water for at least 15 minutes, holding apart lids to insure water contact with all eye and lid tissue surfaces. Notify and report to the Medical Department.
3. Skin Contact - Remove contaminated clothing and wash affected area(s) thoroughly with large quantities of soap and water for at least 10 minutes. Report to Medical Department.
4. Ingestion - Call Medical immediately.

T O B E R E P R I N T E D

A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

SILICATES

THRESHOLD LIMIT VALUE (1973)*: Silicates containing less than 1% crystalline silica.**

Asbestos	5 fibers/cubic centimeter 5 microns in length
Mica	20 m.p.p.c.f. (1)
Soapstone	20 m.p.p.c.f.
Talc (non-asbestiform)	20 m.p.p.c.f.
Tremolite (asbestos)	5 fibers/cc 5u in length
Portland Cement	30 m.p.p.c.f.

EMERGENCY EXPOSURE LIMITS (1969)*: None set

ATMOSPHERIC CONCENTRATIONS IMMEDIATELY HAZARDOUS TO LIFE:
Does not apply

SIGNIFICANT PROPERTIES: Silicate compounds are composed of silicon, oxygen and one or more metals with hydrogen.

EVALUATION OF EXPOSURE: TLV's listed in this bulletin for Silicates are based on crystalline silica levels of 1% or less. If the percent of crystalline silica exceeds 1% then the TLV in mppcf is determined with the formula $\frac{300}{\% \text{ quartz} + 10}$

in which the percent of quartz must be applied to establish the Threshold Limit Value.

USES: In industry silicates have a variety of uses such as: pottery, cements, fillers, abrasives, insulation, abrasive wheels, filter mediums, catalysts, insecticides, refractories, construction material, paints and fillers in plaster.

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Inhalation of high concentrations of silicates can produce a variety of lung ailments. The

* See Appendices A and B for current values

(1) million particles per cubic foot

** For silicate compounds containing more than 1% crystalline silica, calculation of Threshold Limit Value is calculated using the formula $\frac{300}{\% \text{ quartz} + 10}$

SILICATES

physiological reactions caused by inhalation of airborne particulate matter from silicates will vary with the different types of silicates used.

Cardiopulmonary reactions which consist of pneumoconiosis can develop from different silicate exposures such as: silicosis from the silica, asbestosis, from asbestos, talcosis from talc, anthracosilicosis from coals, mica pneumoconiosis from mica, kaolinosiis from kaolin, bauxite pneumoconiosis from aluminum oxide, siderosis from iron oxide, and emphysema, as well as metal poisoning from the various metals contained in the silicates.

B. Eye Contact - Contact with the eyes may cause irritation.

II. SPECIAL HAZARDS - Long term exposures to high concentrations of silicates over many years may produce pneumoconiosis.

III. PRECAUTIONS

A. Personal Protection (See Safety Equipment Manual NAVMAT P-10470 current edition for appropriate protective equipment).

1. Inhalation - Avoid silicate dust exposure. Local exhaust ventilation should be provided for personnel who might be exposed to silicate dusts. For short term emergency exposures or particular situations where local exhaust ventilation is not or cannot be provided (to be determined by Safety and Medical Departments) respirators that are U.S. Bureau of Mines/NIOSH approved for pneumoconiosis - producing dusts or U.S. Bureau of Mines approved air-line respirators or abrasive-blasting helmets, hoods, and masks can be used; however, air supplied respiratory equipment must have an air supply source approved by the Medical Department.

2. Eye Contact - In some situations safety glasses and/or goggles are necessary to protect the eye from airborne and "flying" particles

B. Environmental Protection

1. General room local exhaust ventilation shall be used to prevent harmful accumulations of silicate dusts in work areas atmospheres.

2. Good Housekeeping is important in controlling silicate dust hazards.

IV. STORAGE AND HANDLING - Large quantities of powdered silicates should be stored in tight bins or hoppers. Caked material is best freed by vibrator-type mechanisms mounted on the outside of the storage vessel. If vibrators are not available, use an air lance, or a pole prod to free the material. Personnel should never enter hoppers or bins. Where bins are not dust-tight, suction ventilation should be provided to carry off dust and prevent work area contamination. Exhaust air should be water washed or filtered before release to the outdoors especially if large dust concentrations are present.

V. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - Any person with a history of evidence of chronic lung disease, including arrested tuberculosis should not be exposed to silica. It is recommended that timed vital capacity determinations be obtained routinely. A discrepancy of 10% or more between the observed and the predicted vital capacity, on a three second volume less than 95% of the total should disqualify.

2. Periodic - Periodic examinations should include 14"X17" chest x-rays and timed vital capacity determination. Significant change from previous findings warrant removal from further exposure until careful evaluation of the cause has been made.

B. Medical Management - Since no specific treatment is known, proper medical management should be directed toward preventing disability. Exposure of those with chronic pulmonary disease, such as emphysema, is not warranted.

SILICATES

HAZARDS

Long continued inhalation of silicate dusts may result in incurable lung diseases.

EMERGENCY PROCEDURES

Eyes - If silicate dust gets into the eyes flush the eye with water for several minutes.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH BULLETIN

SULFURIC ACID

SYNONYMS: Oil of Vitriol, Hydrogen Sulfate, Battery Acid

THRESHOLD LIMIT VALUE (1973)*: 1 mg/M³

EMERGENCY EXPOSURE LIMIT (1969)*: 5 mg/M³ for 10 minutes
2 mg/M³ for 30 minutes
1 mg/M³ for 60 minutes

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE:
Not known

SIGNIFICANT PROPERTIES: Sulfuric acid in the concentrated form is a colorless, oily-appearing liquid; dilute solutions resemble water. It has a penetrating, acid-like odor. It is highly corrosive to most metals, non-flammable, but in the concentrated form is a strong oxidizing agent that may cause ignition by contact with combustible materials. Fuming acid (often referred to as "oleum") is an oily, yellow liquid giving off SO₃ at room temperatures. The following properties apply to the concentrated acid.

Chemical Formula	H ₂ SO ₄
Molecular Weight	98
Physical State @ 25°C (77°F)	Liquid
Specific Gravity (96-98% pure)	1.841 20°C (68°F)
Boiling Point (98.3% pure)	338°C (640.4°F)
Melting Point (100% pure)	10.36°C (50.7°F)
Melting Point (98% pure)	3.0°C (37.4°F)
Relative Vapor Density	3.4 (air = 1)
Vapor Pressure @ 145.8°C (294.4°F)	.7mm @ 20°C (68°F)
Solubility	Miscible with water in all proportions and with miscellaneous organic solvents

Maximum Saturated Air Concentration (calculated) @ 20°C (68°F) 934 ppm (3736 mg/M³)

USES: The use of sulfuric acid is wide and varied in industry. Its most common uses include metal cleaning, petroleum refining, fertilizer manufacturing, coke oven gas neutralization, and chemical, plastics, and explosive manufacturing.

* See Appendices A and B for current values

SULFURIC ACID

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Inhalation of fuming sulfuric acid is intensely irritating to the respiratory tract. Inhalation of hot vapors may result in rapid loss of consciousness with serious damage to lung tissue.

B. Skin Contact - Sulfuric acid is rapidly destructive to body tissues, producing severe burns. Repeated contact with dilute solutions may cause dermatitis.

C. Eye Contact - Contact with eyes rapidly causes severe damage which may be followed by total loss of sight.

D. Ingestion - If swallowed, sulfuric acid can cause extreme injury or death.

II. SPECIAL HAZARDS

A. Sulfuric acid is non-flammable but in the concentrated form it is a strong oxidizing agent that may cause ignition by contact with combustible materials. When diluting sulfuric acid, as with any acid, always add the acid to the water. NEVER ADD WATER TO THE ACID.

B. Sulfuric acid will react with metals to produce explosive hydrogen.

III. PRECAUTIONS

A. Personal Protection - See Safety Equipment Manual NAVMAT P-10470 current edition for appropriate protective equipment.

1. Inhalation - Proper exhaust ventilation should be provided for all operations where sulfuric acid solutions are heated or agitated by air or other means, and in lead storage battery charging operations.

(a) If a worker has been exposed to sulfuric acid mist or to the vapors arising from oleum or hot sulfuric acid, he should be removed at once to an uncontaminated area and a physician called.

(b) Employees who may be subject to severe exposure of sulfuric acid should be provided with proper respiratory protection and trained in its use and care. Such exposure may occur in cleaning acid tanks, making repairs

SULFURIC ACID

on tanks, and decontaminating areas following spills. All respiratory equipment should be approved by the U.S. Bureau of Mines/NIOSH for the particular exposure(s) of concern.

2. Skin Contact - Rubber (natural and butyl) gloves and aprons should be worn when there is a possibility of body contact. Protective clothing contaminated by sulfuric acid should be immediately flushed with water and cleaned inside and out each time it is used. Affected areas of the body should be flushed thoroughly with water. Readily accessible, well-marked, rapid action safety showers and eye wash fountains must be available in the areas where sulfuric acid is being handled.

3. Eye Contact - Cup-type or rubber framed goggles equipped with the approved impact resistant glass or plastic lenses, should be worn whenever there is danger of sulfuric acid coming in contact with the eyes. Goggles should be carefully fitted to ensure maximum protection and comfort. Face shield should also be used to protect the face.

4. Ingestion - Containers shall be plainly and appropriately marked as sulfuric acid with the concentration of the acid indicated. With any case of contact with sulfuric acid the Medical Department should be notified immediately.

B. Environmental Protection

1. Provide ample supply of running water and convenient water hoses.

2. Provide eye and skin wash facilities: drinking or eyewash fountain and safety shower.

3. Provide general or local exhaust ventilation as required for all operations where these acid solutions are heated, agitated by air or other means, and lead storage battery charging operations.

IV. STORAGE - Sulfuric acid containers shall be sufficiently vented and isolated from organic materials and such products as nitrites, carbides, chlorates, and metallic powders. The area shall be cool and well-ventilated although heating may be necessary depending on the acid concentration and winter temperatures. Adequate drainage and sufficient quantities of water shall be provided for washing down spills. Electrical fixtures shall be vapor-proof with wiring enclosed in metal conduits. Open lights are prohibited. Drums shall

SULFURIC ACID

be placed with the plugs up and will be vented weekly (more often in hot weather) to relieve accumulation of hydrogen pressure.

V. DISPOSAL AND SPILLAGE - The disposal of this material should be in accordance with accepted practices as delineated in the Disposal Method and Procedures Instruction of each activity or base.

VI. HANDLING - When handling sulfuric acid, the Safety Equipment Manual, NAVMAT P-10470 current edition must be consulted to ensure that the proper protective equipment is employed.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - Individuals with pre-existing asthma or other respiratory or cardiac disease should be excluded from work with this material since excessive exposures may result in bronchial constriction. Individuals with monocular vision, seriously impaired uncorrected vision or chronic skin disorders should also be excluded from working with sulfuric acid.

2. Periodic - No special recommendations.

B. Emergency Treatment

1. Vapor Inhalation - Remove the victim immediately from the contaminated atmosphere. Administration of oxygen, either at atmospheric or positive pressure, is a useful aid in the prevention of pulmonary edema. Consider the use of antibiotics and corticoids.

2. Ingestion - Avoid lavage or emetics. Rinse mouth with large amounts of water and then ingest copious amounts of water, administer a neutralizer and diluent such as: milk of magnesia, lime water (calcium hydroxide), aluminum hydroxide gel or soap solution. Avoid carbonates and bicarbonates (baking soda, chalk, etc.) because they will release carbon dioxide which produces gastric distention and sometimes rupture. Administer a demulcent (olive oil, milk, egg whites, starch water, mineral oil, melted butter).

SULFURIC ACID

3. Skin Contact - Wash immediately with soap and copious quantities of running water, for at least 15 minutes. DO NOT DELAY EVEN TO REMOVE CONTAMINATED CLOTHING; this can be done while the affected body areas are being washed. Subsequent medical treatment is the same as for thermal burns.

4. Eye Contact - If sulfuric acid gets into the eyes, irrigate them immediately for at least 15 minutes with copious quantities of running water, holding the lids apart to ensure water contact with all eye and lid tissue surfaces. Local anesthetic drops may be used for pain and discomfort while irrigating.

VIII. REFERENCE INFORMATION

The following reference(s) is/are germane to this Environmental Health Bulletin:

A. Criteria for a Recommended Standard "Occupational Exposure to Sulfuric Acid", U. S. Dept. of Health, Education, and Welfare, Health Services and Mental Health Administration. National Institute for Occupational Safety and Health (1974).

SULFURIC ACID

HAZARDS

Health Hazard - Sulfuric acid is potentially hazardous even in dilute solutions. It is rapidly destructive to both internal and external body tissues.

EMERGENCY PROCEDURES

1. Vapor Inhalation - Remove the victim immediately from the contaminated atmosphere. Call the Medical Department.
2. Skin Contact - Wash immediately with copious quantities of running water. DO NOT DELAY REMOVING CONTAMINATED CLOTHING; this can be done while the affected body areas are being washed. Notify the Medical Department as quickly as possible. Always add acid to water never the reverse.
3. Eye Contact - If sulfuric acid gets into the eyes, irrigate them immediately with copious quantities of running water, holding the lids apart to ensure water contact with all eye and lid tissue surfaces. Call the Medical Department at once.
4. Taken Internally - If sulfuric acid is taken internally and the worker is conscious encourage him to wash out his mouth with copious quantities of water and then ingest large amounts of water; if the worker is unconscious, place him face down to avoid aspiration and strangulation. In either case, notify the Medical Department immediately.
5. Burns - In cases of severe or extensive sulfuric acid burns, shock symptoms such as rapid pulse, sweating and collapse may appear at any time. In such a case, place the victim on his back (except for an unconscious worker who has swallowed this chemical), continue the prescribed first aid treatment, and keep him warm until the arrival of the Medical Department personnel.
6. Fire - Sulfuric acid is non-flammable but in high concentrations may cause ignition by contact with combustible materials. Smoking is prohibited near open drums and tank cars. Extinguish fires with water, fog, foam, carbon dioxide, or dry chemical.
7. Spills - Dilute and wash away with water.

T O B E R E P R I N T E D
A N D P O S T E D

NAVY ENVIRONMENTAL HEALTH CENTER

XYLENE

SYNONYMS: Xylol, Dimethyl Benzene

THRESHOLD LIMIT VALUE (1973)*: 100 ppm (435 mg/M³)

EMERGENCY EXPOSURE LIMIT: 200 ppm for 60 min.

ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE (1953): Approximately the same as toluene (1600 ppm) but less than benzene (2440 ppm).

SIGNIFICANT PROPERTIES: Xylene is a colorless, flammable liquid with an odor similar to that of toluene. Commercially, it is available as a mixture of o-, m-, and p-isomers. Generally, it is composed of the meta isomer.

Chemical Formula	C ₆ H ₄ (CH ₃) ₂
Molecular Weight	106
Boiling Point	139.1°C (Commercial product is generally the meta isomer: boiling range is 127°C to 159°C)
Flash Point	Meta isomer: 77°F (t.o.c.) ortho isomer: 63°F
Saturated Air Concentration (calculated) @ 32.1°C	13,158 ppm
Solubility	Insoluble in water. Miscible in alcohol, ether, and many organic solvents
Specific Gravity	0.864 (20°C)
Vapor Density	3.66 Air = 1
Vapor Pressure	9.6 mmHg @ 20°C (68°F)
Maximum Saturated Air Concentration (Calculated @ 20°C - 68°F)	12,630 ppm (54,814 mg/M ³)

USES: Xylene is used as a solvent for many different products such as parafin, lacquers, resins, oils, insecticides, etc.; however, the largest use is in aviation gasoline. It is also found as an important intermediate in the manufacture of certain organic compounds. Widely used in histology and pathology labs for a multitude of uses.

* See Appendices A and B for current values.

XYLENE

I. PHYSIOLOGICAL HAZARDS

A. Inhalation - Xylene is a strong irritant to skin and mucous membranes and acts like a narcotic. It causes a depressive state due to action on the central nervous system. Severe exposure results in dizziness, headache, palpitation, loss of appetite, weakness, and a lack of coordination.

B. Skin Contact - Contact with xylene can cause skin disorders in two ways: (1) dryness and cracking due to dissolving of the fatty and sebaceous content of the skin; (2) redness and blistering caused by dissolving the superficial layer. It may also be absorbed through the skin.

C. Eye Contact - Contact of the eyes with xylene should be avoided as it may cause severe irritation.

II. SPECIAL HAZARDS

A. Xylene, when obtained commercially, often has large amounts of benzene present and can cause severe damage due to exposure to the benzene.

B. The fire hazard of xylene is high (1-6% by volume in air). The flash point of o- xylene is 17°C (63°F), and due to its density (3.4 times that of air), it can flow and cause fire in other areas remote from its use.

C. Persons known to use alcohol in large quantities should not be exposed to xylene due to possible synergistic effects. Reactions to xylene are also increased if the exposed person has heart or lung diseases, anemia, or liver or kidney trouble.

III. PRECAUTIONS

A. Personal Protection (See Safety Equipment Manual NAVMAT P-10470 latest edition for the appropriate protective equipment).

1. Inhalation

(a) Local exhaust ventilation must be provided.

(b) For short term emergency exposures of short duration, supplied air respiratory equipment of appropriate design with full face masks must be used. All respiratory protective equipment shall be approved by the U. S. Bureau of Mines/NIOSH for the appropriate exposure(s) of concern.

2. Skin Contact - Aprons, boots, and gloves of polyvinyl alcohol or Buna-N should be worn by workers exposed to liquid xylene.

3. Eye Contact - Face shields or chemical workers' goggles should be worn when exposed to liquid xylene. Contact lenses should not be worn while working with xylene.

4. Ingestion - Eating, drinking and smoking should be prohibited in xylene areas.

IV. STORAGE - Due to the fire-hazard nature of xylene, storage should not be allowed in an area where high heat or open flames are permitted. Care should be taken to avoid punctured containers as xylene is 3.4 times the density of air and will flow along the floor, causing hazardous conditions elsewhere.

V. DISPOSAL OF SPILLS - The disposal of this material should be in accordance with accepted practices as delineated in the Disposal Methods and Procedures Instruction of each activity or base.

VI. HANDLING - Xylene is highly flammable so appropriate care must be exercised during handling and transfer operations.

VII. SPECIAL MEDICAL INFORMATION FOR PHYSICIANS

A. Examinations

1. Preplacement - Persons with chronic dermatitis of exposed skin, any type of blood dyscrasia, or chronic inflammatory eye disease should be excluded from exposure. Contact lenses are prohibited while working with xylene.

2. Periodic - Evaluate skin. Complete blood and platelet counts (because of possible contamination of xylene with benzene).

B. Toxicity

1. Local - Xylene is a mucous membrane irritant. There is minimal skin absorption but exposure may produce dermatitis.

2. Systemic - Xylene produces a CNS narcotic effect. Xylene may produce blood changes if contaminated with benzene (e.g., anemia, leukemia).

XYLENE

C. Emergency Treatment - None specific. Remove from exposure, wash skin and eyes, topical medications if symptomatic; gastric lavage and saline cathartic for ingestion.

XYLENE

HAZARDS

Xylene produces approximately the same hazards as toluene and benzene but due to its vapor pressure, the exposure expected is less than that of benzene. Xylene can cause narcotic-like reactions and dermatitis.

EMERGENCY PROCEDURE

1. Inhalation - Remove the victim from exposure immediately. If breathing has stopped artificial respiration should be given. Call Medical.
2. Eyes - Flood eyes immediately with large amounts of water. Call Medical.
3. Skin - Remove all contaminated clothing immediately and flood exposed skin with large amounts of water. Call Medical.
4. Spills - Extinguish all nearby flames immediately. Clear area of all personnel. Contain the spill (personnel should be wearing appropriate respiratory protection).
5. Ingestion - Secure medical attention IMMEDIATELY.

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APPENDIX A

THE AMERICAN CONFERENCE OF GOVERNMENTAL
INDUSTRIAL HYGIENISTS (ACGIH)
THRESHOLD LIMIT VALUES (TLVs)*

- * These values are revised and will be republished by the Navy Environmental Health Center annually as a part of NAVMED P-5112 with the consent of ACGIH.

PREFACE CHEMICAL CONTAMINANTS

Threshold limit values refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Because of wide variation in individual susceptibility, however, a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit, a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness.

Simple tests are now available (J. Occup. Med. 9: 537, 1967; Ann. N.Y. Acad. Sci., 151, Art. 2: 968, 1968) that may be used to detect those individuals hypersusceptible to a variety of industrial chemicals (respiratory irritants, hemolytic chemicals, organic isocyanates, carbon disulfide). These tests may be used to screen out by appropriate job placement the hyperreactive worker and thus in effect improve the "coverage" of the TLVs.

Threshold limit values refer to time-weighted concentrations for a 7 or 8-hour workday and 40-hour workweek. They should be used as guides in the control of health hazards and should not be used as fine lines between safe and dangerous concentrations. (Exceptions are the substances listed in Appendices E and F and those substances designated with a "C" or Ceiling value, Appendix D)

Time-weighted averages permit excursions above the limit provided they are compensated by equivalent excursions below the limit during the workday. In some instances it may be permissible to calculate the average concentration for a workweek rather than for a workday. The degree of permissible excursion is related to the magnitude of the threshold limit value of a particular substance as given in Appendix D. The relationship between threshold limit and permissible excursion is a rule of thumb and in certain cases may not apply. The amount by which threshold limits may be exceeded for short periods without injury to health depends upon a number of factors

such as the nature of the contaminant, whether very high concentrations—even for short periods—produce acute poisoning, whether the effects are cumulative, the frequency with which high concentrations occur, and the duration of such periods. All factors must be taken into consideration in arriving at decision as to whether a hazardous condition exists.

Threshold limits are based on the best available information from industrial experience, from experimental human and animal studies, and, when possible, from a combination of the three. The basis on which the values are established may differ from substance to substance; protection against impairment of health may be a guiding factor for some, whereas reasonable freedom from irritation, narcosis, nuisance or other forms of stress may form the basis for others.

The amount and nature of the information available for establishing a TLV varies from substance to substance; consequently, the precision of the estimated TLV is also subject to variation and the latest *Documentation* should be consulted in order to assess the extent of the data available for a given substance.

The committee holds to the opinion that limits based on physical irritation should be considered no less binding than those based on physical impairment. There is increasing evidence that physical irritation may initiate, promote or accelerate physical impairment through interaction with other chemical or biologic agents.

In spite of the fact that serious injury is not believed likely as a result of exposure to the threshold limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.

These limits are intended for use in the practice of industrial hygiene and should be interpreted and applied only by a person trained in this discipline. They are not intended for use, or for modification for use,

(1) as a relative index of hazard or toxicity, (2) in the evaluation or control of community air pollution nuisances, (3) in estimating the toxic potential of continuous, uninterrupted exposures, (4) as proof or disproof of an existing disease or physical condition, or (5) for adoption by countries whose working conditions differ from those in the United States of America and where substances and processes differ.

Ceiling vs Time-Weighted Average Limits. Although the time-weighted average concentration provides the most satisfactory, practical way of monitoring airborne agents for compliance with the limits, there are certain substances for which it is inappropriate. In the latter group are substances which are predominantly fast acting and whose threshold limit is more appropriately based on this particular response. Substances with this type of response are best controlled by a ceiling "C" limit that should not be exceeded. It is implicit in these definitions that the manner of sampling to determine compliance with the limits for each group must differ; a single brief sample, that is applicable to a "C" limit, is not appropriate to the time-weighted limit; here, a sufficient number of samples are needed to permit a time-weighted average concentration throughout a complete cycle of operations or throughout the work shift.

Whereas the ceiling limit places a definite boundary which concentrations should not be permitted to exceed, the time-weighted average limit requires an explicit limit to the excursions that are permissible above the listed values. The magnitude of these excursions may be pegged to the magnitude of the threshold limit by an appropriate factor shown in Appendix D. It should be noted that the same factors are used by the Committee in making a judgment whether to include or exclude a substance for a "C" listing.

"Skin" Notation. Listed substances followed by the designation "Skin" refer to the potential contribution to the overall exposure by the cutaneous route including mucous membranes and eye, either by airborne, or more particularly, by direct contact with the substance. Vehicles can

alter skin absorption. This attention-calling designation is intended to suggest appropriate measures for the prevention of cutaneous absorption so that the threshold limit is not invalidated.

Mixtures. Special consideration should be given also to the application of the TLVs in assessing the health hazards which may be associated with exposure to mixtures of two or more substances. A brief discussion of basic considerations involved in developing threshold limit values for mixtures, and methods for their development, amplified by specific examples are given in Appendix C.

Nuisance Particulates. In contrast to fibrogenic dusts which cause scar tissue to be formed in lungs when inhaled in excessive amounts, so-called "nuisance" dusts have a long history of little adverse effect on lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control. The nuisance dusts have also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amount. However, the lung-tissue reaction caused by inhalation of nuisance dusts has the following characteristics: 1) The architecture of the air spaces remains intact. 2) Collagen (scar tissue) is not formed to a significant extent. 3) The tissue reaction is potentially reversible.

Excessive concentrations of nuisance dusts in the workroom air may seriously reduce visibility (iron oxide, carbon black), may cause unpleasant deposits in the eyes, ears and nasal passages (Portland Cement dust), or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by the rigorous skin cleansing procedures necessary for their removal.

A threshold limit of 10 mg/m³, or 30 mppcf, of total dust < 1% quartz is recommended for substances in these categories and for which no specific threshold limits have been assigned. This limit, for a normal workday, does not apply to brief exposures at higher concentrations. Neither does it apply to those substances which may cause

physiologic impairment at lower concentrations but for which a threshold limit has not yet been adopted. Some nuisance particulates are given in Appendix E.

Simple Asphyxiants — “Inert” Gases or Vapors. A number of gases and vapors, when present in high concentrations in air, act primarily as simple asphyxiants without other significant physiologic effects. A TLV may not be recommended for each simple asphyxiant because the limiting factor is the available oxygen. The minimal oxygen content should be 18 percent by volume under normal atmospheric pressure (equivalent to a partial pressure, pO_2 of 135 mm Hg). Atmospheres deficient in O_2 do not provide adequate warning and most simple asphyxiants are odorless. Several simple asphyxiants present an explosion hazard. Account should be taken of this factor in limiting the concentration of the asphyxiant. Specific examples are listed in Appendix F.

Short-Term Limits (STLs). Because many industrial exposures are not continuous, 8-hour daily exposures, but are short-term, or intermittent, to which the TLVs do not necessarily apply, STLs for 5, 15, or 30 minutes for 142 substances have been put into the regulations of the Pennsylvania Department of Health (Chapter 4, Art. 432, Revised Jan. 25, 1968). These STLs represent the maximal average atmospheric concentration of a contaminant to which a worker may be exposed for the stipulated time. The concentration represents an upper limit of exposure and assumes that there is sufficient recovery between exposures before another is initiated. The daily average exposure including that provided by the STL shall be such that the TLV shall not be exceeded.

Similar STLs for a more restricted number of substances have been recommended by the American National Standards Institute. This standard-setting body refers to these short-term limits as “peaks.”

Physical Factors. It is recognized that such physical factors as heat, ultraviolet and ionizing radiation, humidity, abnormal pressure (altitude) and the like may place added stress on the body so that the effects from exposure at a threshold limit may be

altered. Most of these stresses act adversely to increase the toxic response of a substance. Although most threshold limits have built-in safety factors to guard against adverse effects to moderate deviations from normal environments, the safety factors of most substances are not of such a magnitude as to take care of gross deviations. For example, continuous work at temperatures above 90°F or overtime extending the work-week more than 25%, might be considered gross deviations. In such instances judgment must be exercised in the proper adjustments of the threshold limit values.

Biologic Limit Values (BLVs). Other means exist and may be necessary for monitoring worker exposure other than reliance on the Threshold Limit Values for industrial air, namely, the Biologic Limit Values. These values represent limiting amounts of substances (or their effects) to which the worker may be exposed without hazard to health or well-being as determined in his tissues and fluids or in his exhaled breath. The biologic measurements on which the BLVs are based can furnish two kinds of information useful in the control of worker exposure: (1) measure of the individual worker's over-all exposure; (2) measure of the worker's individual and characteristic response. Measurements of response furnish a superior estimate of the physiologic status of the worker, and may be made of (a) changes in amount of some critical biochemical constituent, (b) changes in activity of a critical enzyme, (c) changes in some physiologic function. Measurement of exposure may be made by (1) determining in blood, urine, hair, nails, in body tissues and fluids, the amount of substance to which the worker was exposed; (2) determination of the amount of the metabolite(s) of the substance in tissues and fluids; (3) determination of the amount of the substance in the exhaled breath. The biologic limits may be used as an adjunct to the TLVs for air, or in place of them. The U.S. National Institute for Occupational Safety and Health is proposing a series of these BLVs which will be issued from time to time as part of the Criteria Documents for recommended industrial air standards.

Unlisted substances. There are a number of reasons why a substance does not appear in the Threshold Limit list; either insufficient information is available or it has not been brought to the attention of the Threshold Limits Committee from which a limit can be developed, or it is a substance that could be included in the Appendices E and F pertaining to Nuisance Particulates and Simple Asphyxiants. Substances appearing in these appendices serve as examples only; the appendices are not intended to be inclusive.

"Notice of Intent." At the beginning of each year, proposed actions of the Committee for the forthcoming year are issued in the form of a "Notice of Intended Changes." This Notice provides not only an oppor-

tunity for comment, but solicits suggestions of substances to be added to the list. The suggestions should be accompanied by substantiating evidence. The list of Intended Changes follows the Adopted Values in the TLV booklet.

Legal Status. By publication in the Federal Register (Vol. 36, No. 105, May 29, 1971) the Threshold Limit Values are now official federal standards for industrial air.

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ADOPTED VALUES

Substance	ppm ^{a)}	mg/m ^{3b)}	Substance	ppm ^{a)}	mg/m ^{3b)}
Abate.....	—	10	p-Benzoquinone, see		
Acetaldehyde.....	100	180	Quinone.....	—	—
Acetic acid.....	10	25	Benzoyl peroxide.....	—	5
C Acetic anhydride.....	5	20	Benzyl chloride.....	1	5
Acetone.....	1,000	2,400	Beryllium.....	—	0.002
Acetonitrile.....	40	70	Biphenyl, see Diphenyl.	—	—
Acetylene.....	F	—	Bismuth telluride.....	—	10
Acetylene dichloride, see			Bismuth telluride		
1, 2-Dichloroethylene.	—	—	(Se-doped).....	—	5
Acetylene tetrabromide.	1	14	Boron oxide.....	—	10
Acrolein.....	0.1	0.25	Boron tribromide.....	1	10
Acrylamide—Skin.....	—	0.3	C Boron trifluoride.....	1	3
Acrylonitrile—Skin....	20	45	Bromine.....	0.1	0.7
Aldrin—Skin.....	—	0.25	Bromine pentafluoride..	0.1	0.7
Allyl alcohol—Skin....	2	5	Bromoform—Skin.....	0.5	5
Allyl chloride.....	1	3	Butadiene (1, 3-		
Allyl glycidyl ether			butadiene).....	1,000	2,200
(AGE)—Skin.....	5	22	** Butane.....	—	—
Allyl propyl disulf de....	2	12	Butanethiol, see Butyl		
Alundum (Al ₂ O ₃).....	—	E	mercaptan.....	—	—
4-Aminodiphenyl—Skin.	—	A ^{1b}	2-Butanone.....	200	590
2-Aminoethanol, see			2-Butoxy ethanol (Butyl		
Ethanolamine.....	—	—	Cellosolve)—Skin....	50	240
2-Aminopyridine.....	0.5	2	Butyl acetate (n-butyl		
Ammonia.....	25	18	acetate).....	150	710
Ammonium chloride,			sec-Butyl acetate.....	200	950
fume.....	—	10	tert-Butyl acetate.....	200	950
Ammonium sulfamate			** n-Butyl alcohol—Skin...	—	—
(Ammate).....	—	10	sec-Butyl alcohol.....	150	450
n-Amyl acetate.....	100	525	tert-Butyl alcohol.....	100	300
sec-Amyl acetate.....	125	650	C Butylamine—Skin.....	5	15
Aniline—Skin.....	5	19	C tert-Butyl chromate (as		
Anisidine (o, p-isomers)			CrO ₃)—Skin.....	—	0.1
—Skin.....	0.1	0.5	n-Butyl glycidyl ether		
Antimony & compounds			(BGE).....	50	270
(as Sb).....	—	0.5	** Butyl lactate.....	—	—
ANTU (alpha naphthyl			Butyl mercaptan.....	0.5	1.5
thiourea).....	—	0.3	p-tert-Butyltoluene.....	10	60
Argon.....	F	—	** Cadmium (Metal dust		
** Arsenic & compounds			and soluble salts).....	—	—
(as As).....	—	0.5	*C Cadmium oxide fume (as		
Arsine.....	0.05	0.2	Cd).....	—	0.05
Asphalt (petroleum)			Calcium carbonate.....	—	E
fumes.....	—	5	Calcium arsenate.....	—	1
Azinphos methyl—Skin.	—	0.2	Calcium oxide.....	—	5
* Bagon (Propaxur).....	—	0.5	Camphor (Synthetic)...	2	12
Barium (soluble			Caprolactam		
compounds).....	—	0.5	Dust.....	—	1
** Benzene—Skin.....	—	—	Vapor.....	5	20
Benzidine—Skin.....	—	A ^{1b}			

Substance	ppm ^{a)}	mg/m ^{3b)}
Carbaryl (Sevin®)	—	5
Carbon black	—	3.5
Carbon dioxide	5,000†	9,000
Carbon disulfide—Skin	20	60
Carbon monoxide	50	55
Carbon tetrachloride — Skin	10	65
Cellulose (paper fiber)	—	E
Chlordane — Skin	—	0.5
Chlorinated camphene — Skin	—	0.5
Chlorinated diphenyl oxide	—	0.5
Chlorine	1	3
Chlorine dioxide	0.1	0.3
Chlorine trifluoride	0.1	0.4
Chloroacetaldehyde	1	3
α-Chloroacetophenone (phenacylchloride)	0.05	0.3
Chlorobenzene (monochlorobenzene)	75	350
o-Chlorobenzylidene malononitrile (OCBM) — Skin	0.05	0.4
Chlorobromomethane	200	1,050
2-Chloro-1, 3-butadiene see Chloroprene	—	—
Chlorodiphenyl (42% Chlorine) — Skin	—	1
Chlorodiphenyl (54% Chlorine) — Skin	—	0.5
1-Chloro, 2, 3- epoxy- propane, see Epichlorhydrin	—	—
2-Chloroethanol, see Ethylene chlorohydrin	—	—
Chloroethylene, see Vinyl chloride	—	—
Chloroform (Trichloromethane)	25	120
* bis-Chloromethyl ether	0.001	A ^{1a}
1-Chloro-1-nitropropane	20	100
Chloropicrin	0.1	0.7
Chloroprene (2-chloro-1, 3-butadiene) — Skin	25	90
* o-Chlorotoluene	50	250
Chromates, certain insol- uble forms	—	A ^{1a}
Chromic acid and chromates (as CrO ₃)	—	0.1
Chromium, sol. chromic, chromous salts as Cr	—	0.5

Substance	ppm ^{a)}	mg/m ³
Coal tar pitch volatiles (benzene soluble frac- tion: anthracene, BaP, phenanthrene, acri- dine, chrysene, pyrene)	A ^{1a}	0.2
Cobalt, metal fume & dust	—	0.1
** Copper fume	—	—
Dusts and Mists	—	1
Corundum (Al ₂ O ₃)	—	E
* Cotton Dust (raw)	—	0.2 ^{m)}
Crag® herbicide	—	10
Cresol (all isomers) — Skin	5	22
Crotonaldehyde	2	6
Cumene — Skin	50	245
Cyanide (as CN) — Skin	—	5
Cyanogen	10	—
Cyclohexane	300	1,050
Cyclohexanol	50	200
Cyclohexanone	50	200
Cyclohexene	300	1,015
* Cyclohexylamine—Skin	10	40
Cyclopentadiene	75	200
2, 4-D	—	10
DDT	—	1
DDVP, see Dichlorvos	—	—
Decaborane — Skin	0.05	0.3
Demeton® — Skin	0.01	0.1
Diacetone alcóhol (4- hydroxy-4-methyl- 2-pentanone)	50	240
1, 2-Diaminoethane, see Ethylenediamine	—	—
Diazinon — Skin	—	0.1
Diazomethane	0.2	0.4
Diborane	0.1	0.1
1, 2-Dibromoethane (ethylene dibromide) — Skin	20	145
Dibrom®	—	3
2-N Dibutylaminoethanol — Skin	2	14
Dibutyl phosphate	1	5
Dibutylphthalate	—	5
C Dichloracetylene	0.1	0.4
C o-Dichlorobenzene	50	300
p-Dichlorobenzene	75	450
Dichlorobenzidine — Skin	—	A ^{1b}

Substance	ppm ^{a)}	mg/m ^{3b)}
Dichlorodifluoromethane.	1,000	4,950
1, 3-Dichloro-5, 5-dimethyl hydantoin...	—	0.2
1, 1-Dichloroethane.....	200	320
1, 2-Dichloroethane.....	50	200
1, 2-Dichloroethylene...	200	790
Dichloroethyl ether — Skin.....	5	30
Dichloromethane, see Methylene chloride...	—	—
Dichloromonofluoromethane.....	1,000	4,200
C 1, 1-Dichloro-1-nitroethane.....	10	60
1, 2-Dichloropropane, see Propylenedichloride...	—	—
Dichlorotetrafluoroethane.....	1,000	7,000
Dichlorvos (DDVP) — Skin.....	0.1	1
Dieldrin — Skin.....	—	0.25
Diethylamine.....	25	75
Diethylamino ethanol — Skin.....	10	50
Diethylene triamine — Skin.....	1	4
Diethylether, see Ethyl ether.....	—	—
Difluorodibromomethane.....	100	860
C Diglycidyl ether (DGE).	0.5	2.8
Dihydroxybenzene, see Hydroquinone.....	—	—
Diisobutyl ketone.....	25	150
Diisopropylamine — Skin.....	5	20
Dimethoxymethane, see Methylal.....	—	—
Dimethyl acetamide — Skin.....	10	35
Dimethylamine.....	10	18
Dimethylaminobenzene, see Xylidene.....	—	—
Dimethylaniline (N-dimethylaniline) — Skin.....	5	25
Dimethylbenzene, see Xylene.....	—	—
Dimethyl 1, 2-dibromo-2-dichloroethyl phosphate, see DiBrom....	—	—
Dimethylformamide — Skin.....	10	30

Substance	ppm ^{a)}	mg/m ^{3b)}
2, 6-Dimethylheptanone, see Diisobutyl ketone.	—	—
1, 1-Dimethylhydrazine — Skin.....	0.5	1
Dimethylphthalate.....	—	5
** Dimethylsulfate — Skin.	—	—
Dinitrobenzene (all isomers) — Skin.....	0.15	1
Dinitro-o-cresol — Skin.	—	0.2
Dinitrotoluene — Skin..	—	1.5
* Dioxane, technical grade — Skin.....	50	180
Diphenyl.....	0.2	1
Diphenyl amine.....	—	10
Diphenylmethane diisocyanate, see Methylene bisphenyl isocyanate (MDI)....	—	—
Dipropylene glycol methyl ether — Skin.	100	600
Diquat.....	—	0.5
Di-sec, octyl phthalate (Di-2-ethylhexyl-phthalate).....	—	5
* Disyston — Skin.....	—	0.1
Emery.....	—	E
Endosulfan (Thiodan®) — Skin.....	—	0.1
Endrin — Skin.....	—	0.1
Epichlorhydrin — Skin..	5	19
EPN — Skin.....	—	0.5
1, 2-Epoxypropane, see Propyleneoxide.....	—	—
2, 3-Epoxy-1-propanol, see Glycidol.....	—	—
Ethane.....	F	—
Ethanethiol, see Ethylmercaptan.....	—	—
Ethanolamine.....	3	6
2-Ethoxyethanol — Skin.	100	370
2-Ethoxyethylacetate (Cellosolve acetate) — Skin.....	100	540
Ethyl acetate.....	400	1,400
Ethyl acrylate — Skin..	25	100
Ethyl alcohol (ethanol)..	1,000	1,900
Ethylamine.....	10	18
Ethyl sec-amyl ketone (5-methyl-3-heptanone)..	25	130
Ethyl benzene.....	100	435
Ethyl bromide.....	200	890
Ethyl butyl ketone (3-Heptanone).....	50	230

Substance	ppm ^{a)}	mg/m ^{3b)}	Substance	ppm ^{a)}	mg/m ^{3b)}
Ethyl chloride.....	1,000	2,600	Heptachlor—Skin.....	—	0.5
Ethyl ether.....	400	1,200	** Heptane (n-heptane)....	—	—
Ethyl formate.....	100	300	* Hexachlorocyclopenta-		
Ethyl mercaptan.....	0.5	1	diene.....	0.01	0.11
Ethyl silicate.....	100	850	Hexachloroethane—		
Ethylene.....	F	—	Skin.....	1	10
Ethylene chlorohydrin—			Hexachloronaphthalene		
Skin.....	5	16	—Skin.....	—	0.2
Ethylenediamine.....	10	25	Hexafluoroacetone.....	0.1	0.7
Ethylene dibromide, see			** Hexane (n-hexane).....	—	—
1, 2-Dibromoethane...	—	—	2-Hexanone.....	100	410
Ethylene dichloride, see			Hexone (Methyl isobutyl		
1, 2-Dichloroethane...	—	—	ketone).....	100	410
Ethylene glycol, particu-			sec-Hexyl acetate.....	50	300
late.....	—	10	Hydrazine—Skin.....	1	1.3
Ethylene glycol, vapor..	100	260	Hydrogen.....	F	—
C Ethylene glycol dinitrate			Hydrogen bromide.....	3	10
and/or Nitroglycerin—			C Hydrogen chloride.....	5	7
Skin.....	0.2 ^{d)}	—	Hydrogen cyanide—		
Ethylene glycol mono-			Skin.....	10	11
methyl ether acetate			Hydrogen fluoride.....	3	2
(Methyl cellosolve ace-			Hydrogen peroxide.....	1	1.4
tate)—Skin.....	25	120	Hydrogen selenide.....	0.05	0.2
Ethylene imine—Skin..	0.5	1	Hydrogen sulfide.....	10	15
Ethylene oxide.....	50	90	Hydroquinone.....	—	2
Ethylidene chloride, see			Indene.....	10	45
1, 1-Dichloroethane...	—	—	Indium and compounds,		
*C Ethylidene norbornene..	5	25	as In.....	—	0.1
N-Ethylmorpholine—			C Iodine.....	0.1	1
Skin.....	20	94	** Iron oxide fume.....	—	—
Ferbam.....	—	10	Iron pentacarbonyl....	0.01	0.08
Ferrovandium dust....	—	1	Iron salts, soluble, as Fe.	—	1
Fluoride (as F).....	—	2.5	Isoamyl acetate.....	100	525
Fluorine.....	1	2	Isoamyl alcohol.....	100	360
Fluorotrichloromethane.	1,000	5,600	Isobutyl acetate.....	150	700
C Formaldehyde.....	2	3	** Isobutyl alcohol.....	—	—
Formic acid.....	5	9	** Isophorone.....	—	—
Furfural—Skin.....	5	20	Isopropyl acetate.....	250	950
* Furfuryl alcohol.....	5	20	Isopropyl alcohol—Skin.	400	980
Gasoline.....	—	B ²	Isopropylamine.....	5	12
Germanium tetrahydride	0.2	0.6	Isopropylether.....	250	1,050
Glass, fibrous ^{e)} or dust...	—	E	Isopropyl glycidyl ether		
Glycerin mist.....	—	E	(IGE).....	50	240
Glycidol (2, 3-Epoxy-1-			Kaolin.....	—	E
propanol).....	50	150	Ketene.....	0.5	0.9
Glycol monoethyl ether,			Lead, inorg., fumes and		
see 2-Ethoxyethanol..	—	—	dusts.....	—	0.15
Graphite, (Synthetic)...	—	E	Lead arsenate.....	—	0.15
Guthion, [®] see Azinphos-			Limestone.....	—	E
methyl.....	—	—	Lindane.....	—	0.5
Gypsum.....	—	E	Lithium hydride.....	—	0.025
Hafnium.....	—	0.5	L.P.G. (Liquified petro-		
Helium.....	F	—	leum gas).....	1,000	1,800

Substance	ppm ^{a)}	mg/m ^{3b)}
Magnesite.....	—	E
Magnesium oxide fume..	—	10
Malathion—Skin.....	—	10
Maleic anhydride.....	0.25	1
C Manganese and com- pounds, as Mn.....	—	5
* Manganese cyclopenta- dienyl tricarbonyl (as Mn)—Skin.....	—	0.1
Marble.....	—	E
Mercury (Alkyl com- pounds) — Skin.....	0.001	0.01
Mercury (All forms ex- cept alkyl).....	—	0.05
Mesityl oxide.....	25	100
Methane.....	F	—
Methanethiol, see Methyl mercaptan.....	—	—
Methoxychlor.....	—	10
2-Methoxyethanol—Skin (Methyl cellosolve)...	25.	80
Methyl acetate.....	200	610
Methyl acetylene (pro- pyne).....	1,000	1,650
Methyl acetylene- propadiene mixture (MAPP).....	1,000	1,800
Methyl acrylate — Skin..	10	35
Methyl acrylonitrile — Skin.....	1	3
Methylal (dimethoxy- methane).....	1,000	3,100
Methyl alcohol (metha- nol)—Skin.....	200	260
Methylamine.....	10	12
Methyl amyl alcohol, see Methyl isobutyl carbi- nol.....	—	—
Methyl 2-cyanoacrylate..	2	8
Methyl isoamyl ketone..	100	475
Methyl (n-amyl) ketone (2-Heptanone).....	100	465
Methyl bromide — Skin..	15	60
Methyl butyl ketone, see 2-Hexanone.....	—	—
Methyl cellosolve — Skin see 2-Methoxyethanol.	—	—
Methyl cellosolve acetate — Skin, see Ethylene glycol monomethyl ether acetate.....	—	—
Methyl chloride.....	100	210

Substance	ppm ^{a)}	mg/m ^{3b)}
Methyl chloroform.....	350	1,900
** Methylcyclohexane.....	—	—
Methylcyclohexanol....	50	235
o-Methylcyclohexanone- — Skin.....	50	230
Methylcyclopentadienyl manganese tricarbonyl (as Mn) — Skin.....	0.1	0.2
Methyl demeton — Skin..	—	0.5
Methyl ethyl ketone (MEK), see 2-Bu- tanone.....	—	—
*C Methyl ethyl ketone peroxide.....	0.2	1.5
Methyl formate.....	100	250
Methyl iodide — Skin...	5	28
Methyl isobutyl carbinol — Skin.....	25	100
Methyl isobutyl ketone, see Hexone.....	—	—
Methyl isocyanate — Skin.....	0.02	0.05
Methyl mercaptan.....	0.5	1
Methyl methacrylate....	100	410
Methyl parathion—Skin..	—	0.2
Methyl propyl ketone, see 2-Pentanone.....	—	—
C Methyl silicate.....	5	30
C α Methyl styrene.....	100	480
C Methylene bisphenyl iso- cyanate (MDI).....	0.02	0.2
** Methylene chloride (di- chloromethane).....	—	—
* 4,4'-Methylene bis (2- chloraniline)—Skin...	0.02	A ²
*C Methylene bis (4-cyclo- hexylisocyanate).....	0.01	0.11
Molybdenum (soluble compounds)..	—	5
(insoluble compounds).	—	10
Monomethyl aniline — Skin.....	2	9
C Monomethyl hydrazine — Skin.....	0.2	0.35
Morpholine — Skin.....	20	70
Naphtha (coal tar).....	100	400
Naphthalene.....	10	50
β-Naphthylamine.....	—	A ^{1b}
Neon.....	F	—
Nickel carbonyl.....	0.001	A ^{1a} 0.007
Nickel, metal and insol- uble compounds (as Ni)	—	1

Substance	ppm ^{a)}	mg/m ^{3b)}	Substance	ppm ^{a)}	mg/m ^{3b)}
** Nickel, soluble compounds (as Ni).....	—	—	Phenyl ether (vapor)....	1	7
Nicotine — Skin.....	0.075	0.5	Phenyl ether-Diphenyl mixture (vapor).....	1	7
Nitric acid.....	2	5	Phenylethylene, see Styrene.....	—	—
Nitric oxide.....	25	30	Phenyl glycidyl ether (PGE).....	10	60
p-Nitroaniline — Skin...	1	6	Phenylhydrazine — Skin.	5	22
Nitrobenzene — Skin....	1	5	C Phenylphosphine.....	0.05	0.25
p-Nitrochlorobenzene — Skin.....	—	1	* Phorate (Thimet®)—Skin	—	0.05
4-Nitrodiphenyl.....	—	A ^{1a}	Phosdrin (Mevinphos)® — Skin.....	0.01	0.1
Nitroethane.....	100	310	** Phosgene (carbonyl chloride).....	—	—
C Nitrogen dioxide.....	5	9	Phosphine.....	0.3	0.4
Nitrogen trifluoride.....	10	29	Phosphoric acid.....	—	1
Nitroglycerin — Skin....	0.2	2	Phosphorus (yellow)....	—	0.1
Nitromethane.....	100	250	Phosphorus pentachloride.....	—	1
1-Nitropropane.....	25	90	Phosphorus pentasulfide.	—	1
2-Nitropropane.....	25	90	Phosphorus trichloride..	0.5	3
N-Nitrosodimethylamine (dimethylnitrosoamine) — Skin.....	—	A ²	Phthalic anhydride.....	2	12
Nitrotoluene — Skin....	5	30	Pieric acid — Skin.....	—	0.1
Nitrotrichloromethane, see Chloropicrin.....	—	—	Pival® (2-Pivalyl-1, 3-indandione).....	—	0.1
Nitrous oxide.....	F	—	Plaster of Paris.....	—	E
Octachloronaphthalene — Skin.....	—	0.1	Platinum (Soluble Salts) as Pt.....	—	0.002
** Octane.....	—	—	Polychlorobiphenyls, see Chlorodiphenyls.....	—	—
Oil mist, particulate....	—	5 ^{o)}	Polytetrafluoroethylene decomposition products.....	—	B ¹
Oil mist, vapor.....	^{o)} B ²	—	*C Potassium hydroxide....	—	2
Osmium tetroxide.....	0.0002	0.002	Propane.....	F	—
Oxalic acid.....	—	1	β Propiolactone.....	—	A ²
Oxygen difluoride.....	0.05	0.1	Propargyl alcohol—Skin.	1	2
Ozone.....	0.1	0.2	n-Propyl acetate.....	200	840
* Paraffin wax fume.....	—	2	Propyl alcohol—Skin...	200	500
Paraquat — Skin.....	—	0.5	n-Propyl nitrate.....	25	110
Parathion — Skin.....	—	0.1	Propylene dichloride (1, 2-Dichloropropane)...	75	350
Pentaborane.....	0.005	0.01	Propylene glycol monomethyl ether.....	100	360
Pentachloronaphthalene — Skin.....	—	0.5	Propylene imine — Skin.	2	5
Pentachlorophenol — Skin.....	—	0.5	Propylene oxide.....	100	240
Pentaerythritol.....	—	E	Propyne, see Methylacetylene.....	—	—
** Pentane.....	—	—	Pyrethrum.....	—	5
2-Pentanone.....	200	700	Pyridine.....	5	15
Perchloroethylene.....	100	670	Quinone.....	0.1	0.4
Perchloromethyl mercaptan.....	0.1	0.8	RDX — Skin.....	—	1.5
Perchloryl fluoride.....	3	14	Rhodium, Metal fume and dusts (as Rh)....	—	0.1
Petroleum Distillates (naphtha).....	^{o)} B ³	—	Soluble salts.....	—	0.001
Phenol — Skin.....	5	19			
Phenothiazine — Skin...	—	5			
p-Phenylene diamine — Skin.....	—	0.1			

Substance	ppm ^{a)}	mg/m ^{3b)}	Substance	ppm ^{a)}	mg/m ^{3b)}
Ronnel.....	—	10	Tetrachloromethane, see Carbon tetrachloride..	—	—
Rosin Core Solder, pyrolysis products (as formaldehyde).....	—	0.1	Tetrachloronaphthalene — Skin.....	—	2
Rotenone (commercial)..	—	5	Tetraethyl lead (as Pb) — Skin.....	—	0.100 ^{h)}
Rouge.....	—	E	Tetrahydrofuran.....	200	590
Selenium compounds (as Se).....	—	0.2	Tetramethyl lead (as Pb) — Skin.....	—	0.150 ^{h)}
Selenium hexafluoride... 0.05	0.05	0.4	Tetramethyl succinoni- trile — Skin.....	0.5	3
* Sevin® (see Carbaryl)...	—	—	Tetranitromethane.....	1	8
* Silane (see Silicon tetra- hydride).....	—	—	Tetryl (2, 4, 6- trinitrophenyl- methylnitramine) — Skin.....	—	1.5
Silicon.....	—	E	Thallium (soluble com- pounds) — Skin (as Tl) ..	—	0.1
Silicon carbide.....	—	E	Thiram®.....	—	5
* Silicon tetrahydride (Silane).....	0.5	0.7	Tin (inorganic com- pounds, except SnH ₄ and SnO ₂) as Sn.....	—	2
Silver, metal and soluble compounds.....	—	0.01	Tin (organic compounds) — Skin (as Sn).....	—	0.1
Sodium fluoroacetate (1080) — Skin.....	—	0.05	Tin oxide.....	—	E
**C Sodium hydroxide.....	—	—	Titanium dioxide.....	—	E
Starch.....	—	E	Toluene (toluol) — Skin.	100	375
Stibine.....	0.1	0.5	C Toluene-2, 4- diisocyanate.....	0.02	0.12
** Stoddard solvent.....	—	—	o-Toluidine.....	5	22
Strychnine.....	—	0.15	Toxaphene, see Chlори- nated camphene.....	—	—
Styrene (Monomer) (Phenyl ethylene)....	100	420	Tributyl phosphate.....	—	5
Sucrose.....	—	E	1, 1, 1-Trichloroethane, see Methyl chloroform.	—	—
Sulfur dioxide.....	5	13	1, 1, 2-Trichloroethane — Skin.....	10	45
Sulfur hexafluoride..... 1,000	1,000	6,000	Trichloroethylene.....	100	535
Sulfuric acid.....	—	1	Trichloromethane, see Chloroform.....	—	—
Sulfur monochloride....	1	6	Trichloronaphthalene — Skin.....	—	5
Sulfur pentafluoride.... 0.025	0.025	0.25	1, 2, 3-Trichloropropane.	50	300
Sulfur tetrafluoride..... 0.1	0.1	0.4	1, 1, 2-Trichloro 1, 2, 2- trifluoroethane.....	1,000	7,600
Sulfuryl fluoride.....	5	20	Triethylamine.....	25	100
Systox, see Demeton®...	—	—	Trifluoromonobromo- methane.....	1,000	6,100
2, 4, 5-T.....	—	10	Trimethyl benzene.....	25	120
Tantalum.....	—	5	2, 4, 6-Trinitrophenol, see Picric acid.....	—	—
TEDP — Skin.....	—	0.2	2, 4, 6 — Trinitrophenyl- methylnitramine, see Tetryl.....	—	—
Teflon® decomposition products.....	—	B ¹			
Tellurium.....	—	0.1			
Tellurium hexafluoride.. 0.02	0.02	0.2			
TEPP — Skin.....	0.004	0.05			
C Terphenyls.....	1	9			
1, 1, 1, 2-Tetrachloro-2, 2-difluoroethane.....	500	4,170			
1, 1, 2, 2-Tetrachloro-1, 2-difluoroethane.....	500	4,170			
1, 1, 2, 2-Tetrachloro- ethane — Skin.....	5	35			
Tetrachloroethylene, see Perchloroethylene....	—	—			

Substance	ppm ^{a)}	mg/m ^{3b)}
Trinitrotoluene — Skin..	0.2	1.5
Triorthocresyl phosphate.....	—	0.1
Triphenyl phosphate....	—	3
Tungsten & compounds, as W		
Soluble.....	—	1
Insoluble.....	—	5
Turpentine.....	100	560
Uranium (natural) soluble & insoluble compounds, as U.....	—	0.2
Vanadium (V ₂ O ₅), as V		
Dust.....	—	0.5
C Fume.....	—	0.05
Vinyl acetate.....	10	30
Vinyl benzene, see Styrene.....	—	—

Substance	ppm ^{a)}	mg/m ^{3b)}
Vinyl bromide.....	250	1,100
** Vinyl chloride.....	—	—
Vinylcyanide, see Acrylonitrile.....	—	—
Vinyl toluene.....	100	480
Warfarin.....	—	0.1
Wood dust (nonallergenic).....	—	5
Xylene (xylol) — Skin..	100	435
Xylidine — Skin.....	5	25
Yttrium.....	—	1
Zinc chloride fume....	—	1
Zinc oxide fume.....	—	5
* Zinc stearate.....	—	E
Zirconium compounds (as Zr).....	—	5

Capital letters refer to Appendices.
Footnotes (a thru h) see Pages 15.

*1974 Addition.

**See Notice of Intended Changes.

MINERAL DUSTS

Substance SILICA, SiO₂

Crystalline

Quartz

$$\begin{aligned}
 & \text{TLV in mppcf:} \\
 & \quad \frac{300^j)}{ \% \text{ quartz} + 10} \\
 & \text{TLV for respirable dust} \\
 & \text{in mg/m}^3: \\
 & \quad \frac{10 \text{ mg/m}^3{}^{3k)}}{ \% \text{ Respirable quartz} + 2} \\
 & \text{TLV for "total dust," res-} \\
 & \text{pirable and nonrespirable:} \\
 & \quad \frac{30 \text{ mg/m}^3}{ \% \text{ quartz} + 3}
 \end{aligned}$$

Cristobalite Use one-half the value calculated from the count or mass formulae for quartz.

Tridymite Use one-half the value calculated from formulae for quartz.

Silica, fused

Use quartz formulae.

Amorphous 20 mppcfⁱ⁾

SILICATES (< 1% quartz)

*Asbestos, all forms† 5 fibers/cc > 5μm in lengthⁿ⁾; A^{1a}
 Graphite (natural) 15 mppcf
 Mica 20 mppcf
 *Mineral wool fiber 10 mg/m³
 Perlite 30 mppcf
 Portland Cement 30 mppcf
 Soapstone 20 mppcf
 Talc (nonasbestiform) 20 mppcf

Talc (fibrous) use Asbestos limit.
 Tremolite, see Asbestos.

*Tripoli, use respirableⁿ⁾ mass quartz formula

COAL DUST

(bituminous). 2 mg/m³ (respirable dust fraction < 5% quartz).

If > 5% quartz use respirable mass formula.

†A more stringent TLV for crocidolite may be required.

NUISANCE PARTICULATES

(see Appendix E)

30 m.p.p.c.f. or 10 mg/m³
 of total dust < 1% quartz

Conversion factors

mppef \times 35.3 = million particles per
 cubic meter
 = particles per c.c.

- | | Aerodynamic
Diameter (μ m)
(unit density sphere) | % passing
selector |
|---|--|-----------------------|
| a) Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm. Hg. pressure. | ≥ 2 | 90 |
| b) Approximate milligrams of substance per cubic meter of air. | 2.5 | 75 |
| d) An atmospheric concentration of not more than 0.02 ppm, or personal protection may be necessary to avoid headache. | 3.5 | 50 |
| e) $< 7 \mu$ m in diameter. | 5.0 | 25 |
| f) As sampled by method that does not collect vapor. | 10 | 0 |
| g) According to analytically determined composition. | | |
| h) For control of general room air, biologic monitoring is essential for personnel control. | | |
| i) Millions of particles per cubic foot of air, based on impinger samples counted by light-field technics. | | |
| j) The percentage of quartz in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable. | | |
| k) Both concentration and percent quartz for the application of this limit are to be determined from the fraction passing a size-selector with the following characteristics: | | |
| | l) containing <1% quartz; if quartz content > 1%, use formulae for quartz. | |
| | m) Lint free dust as measured by the vertical-elutriator, cotton-dust sampler described in the Transactions of the National Conference on Cotton Dust, J. R. Lynch, pg. 33, May 2, 1970. | |
| | n) As determined by the membrane filter method at 400-450 X magnification (4 mm objective) phase contrast illumination. | |
| | o) Based on "high volume" sampling. | |
| | p) "Respirable" dust as defined by the British Medical Research Council Criteria (1) and as sampled by a device producing equivalent results (2). | |
| | (1) Hatch, T. E. and Gross, P., Pulmonary Deposition and Retention of Inhaled Aerosols, p. 149. Academic Press, New York, New York, 1964. | |
| | (2) Interim Guide for Respirable Mass Sampling, AIHA Aerosol Technology Committee, AIHA J. 31: 2, 1970, p. 133. | |

NOTICE OF INTENDED CHANGES (for 1974)

These substances, with their corresponding values, comprise those for which either a limit has been proposed for the first time, or for which a change in the "Adopted" listing has been proposed. In both cases, the proposed limits should be considered trial limits that will remain in the listing for a period of at least two years. If, after two years no evidence comes to light that questions the appropriateness of the values herein, the values will be reconsidered for the "Adopted" list. Documentation is available for each of these substances.

Substance	ppm ^{a)}	mg/m ^{3b)}
+ Arsenic, inorganic compounds (as As).....	—	0.25
+ Benzene—Skin.....	10	30
+ Butane.....	600	1,450
+ n-Butyl alcohol.....	50	150
+ n-Butyl lactate.....	5	25
+ Cadmium dusts & salts...	—	0.05
C Cadmium oxide fume....	—	0.05
+ Calcium cyanamide.....	—	0.5
+ Calcium hydroxide.....	—	2
+ Captan.....	—	5
+ Carbofuran.....	—	0.10
Carbon tetrabromide....	0.1	1.4
Catechol (Pyrocatechol)..	1	4.5
Cesium hydroxide.....	—	2
Chlorodifluoromethane... 1000	3500	
Chlorpyrifos (Dursban®)		
—Skin.....	—	0.2
o-Chlorostyrene.....	50	285
2-Chloro-6-(trichloromethyl) pyridine (N-Serve®).....	—	10
Clopidol (Coyden®).....	—	10
Copper fume.....	—	0.2
Crufomate (Ruelene®)...	—	5
+ Dicyclopentadiene.....	5	30
Dicyclopentadienyliron...	—	10
Diethylphthalate.....	—	5
+ Dimethyl sulfate—Skin..	—	A ²
3,5-Dinitro-o-toluamide (Zoalene®).....	—	5
+ Disulfuram.....	—	2
2,6-Ditert. butyl-p-cresol	—	10
+ Dyfonate.....	—	0.1
+C Ethylene chlorohydrin —		
Skin.....	1	3
+ Fensulfothion (Dasanit)..	—	0.1
Formamide.....	20	30

TLV

Substance	ppm ^{a)}	mg/m ^{3b)}
+C Glutaraldehyde.....	2	8
+C Glutaraldehyde (Alkaline activated).....	—	0.25
+ Heptane.....	400	1,600
+ Hexane.....	100	360
+ Hexylene glycol.....	25	125
+ Hydrogenated terphenyls	0.4	4.4
+ Iodoform.....	0.2	3.0
Iron oxide fume.....	B ⁴	5
+ Isobutyl alcohol.....	50	150
+ Isophorone.....	5	25
+ Methylcyclohexane.....	400	1,600
+ Methylene chloride (Dichloromethane).....	100	360
+ Nickel, soluble salts (as Ni)	—	0.1
+ Nonane.....	200	1,050
+ Octane.....	300	1,450
+ Pentane.....	600	1,800
+C Phosgene.....	0.05	0.2
Picloram (Tordon®).....	—	10
+ Resorcinol.....	10	45
+C Sodium azide.....	0.1	0.3
C Sodium hydroxide.....	—	2.0
+ Stoddard Solvent.....	100	575
C Subtilisins (Proteolytic enzymes as 100% pure crystalline enzyme).....	—	0.00006 ^{c)}
+ Succindialdehyde (see Glutaraldehyde).....	—	—
+ 4,4'-Thiobis (6-tert butyl-m-cresol).....	—	10
Tricyclohexyltin hydroxide (Plictran®).....	—	5
+ Triphenylamine.....	—	5
+ Vinyl chloride.....	Pending	A ^{1c}
Vinylidene chloride.....	10	40
+ Welding fumes (Total Particulate).....	—	5&B ⁴
+ m-Xylene, α, α'-Diamine...	—	0.1

a) Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm. Hg. pressure.

b) Approximate milligrams of particulate per cubic meter of air.

NOTICE OF INTENDED CHANGES (Cont'd) **MINERAL DUSTS**

Substance	TLV
+ Diatomaceous earth (Natural, uncalcined) ..	1 mg/m ³
Silica flour.....	Use respirable ^{a)} mass formula for quartz.

Capital letters refer to Appendices.

^{a)}1974 Addition.

For explanations of o) and p), see pg. 15.

APPENDIX A

Carcinogens

The Committee lists below those substances in industrial use that have proven carcinogenic in man, or have induced cancer in animals under appropriate experimental conditions. Present listing of those substances carcinogenic for man takes three forms, those for which a TLV has been assigned (1a), those for which environmental conditions have not been sufficiently defined to assign a TLV (1b), and 1c, those whose reassignment of a TLV is awaiting more definitive data, and hence should be treated as a 1b carcinogen.

- 1a. *Human Carcinogens* — Substances recognized as occupational carcinogens with an assigned TLV:

Asbestos, all forms, 5 fibers/cc > 5 μ m in length.

bis (Chloromethyl) ether, 1ppb.

Chromates, certain insoluble forms, (Pb, Zn, and chromate-chromite ore, 100 μ g/m³, as Cr)

Coal tar pitch volatiles 200 μ g/m³

Nickel carbonyl, 1ppb

- 1b. *Human Carcinogens* — Substances known to be potent occupational carcinogens without an assigned TLV:

4-Aminodiphenyl (p-Xenylamine)

Benzidine & its salts

beta-Naphthylamine

4-Nitrodiphenyl

- 1c. *Human Carcinogens*—Substances awaiting reassignment of TLV because of recently discovered carcinogenicity.

Vinyl chloride, TLV pending.

For the substances in 1b, no exposure or contact by any route, respiratory, skin or oral, as detected by the most sensitive methods, shall be permitted. "No exposure or contact" means hermitizing the process or operation by the best practicable engineering methods. The worker should be properly equipped to insure virtually no contact with the carcinogen.

2. *Experimental Carcinogens* — Industrial substances found to be capable of inducing tumors under experimental conditions in animals:

TLV

Beryllium 0.002 mg/m³

3, 3'-Dichlorobenzidine

Dimethyl sulfate

Ethylenimine

4, 4'-Methylene bis (2-chloroaniline)

N-Nitrosodimethylamine

beta-Propiolactone

For the above, worker exposure by all routes should be carefully controlled to levels consistent with the animal and human experience data, except for those substances with a listed TLV.

APPENDIX B

B¹ *Polytetrafluoroethylene* decomposition products.* Thermal decomposition of the fluorocarbon chain in air leads to the formation of oxidized products containing carbon, fluorine and oxygen. Because these products decompose in part by hydrolysis in alkaline solution, they can be quantitatively determined in air as fluoride to provide an index of exposure. No TLV is recommended pending determination of the toxicity of the products, but air concentrations should be kept below the limit of sensitivity of the analytic method.

B² *Gasoline.* The composition of gasoline varies greatly and thus a single TLV for all types of these materials is no longer applicable. In general, the aromatic hydrocarbon content will determine what TLV applies. Consequently the content of benzene, other aromatics and additives should be determined to arrive at the appropriate TLV (Elkins, et al. A.I.H.A.J. 24: 99, 1963).

B³ *Petroleum Distillates.* For petroleum distillates for which no specific TLV's are listed, approximate values can be obtained by use of the following equation:

$$\text{TLV} = \frac{100}{\frac{\% \text{ Al}}{3.6(200 - \text{B.P. } ^\circ\text{C.}) + 20} + \frac{\% \text{ Ar}}{1.3(200 - \text{B.P. } ^\circ\text{C.}) + 10}} \text{ ppm}$$

where Al = aliphatic component

Ar = aromatic component

B.P. = mean boiling point in degrees centigrade (normally the 50% distillation temperature).

The equation cannot be used if the benzene content of the fraction exceeds 1%, nor if the mean boiling point is above 200°C.

It may also lead to error if there are large amounts of hexane or cyclohexane in the distillate.

If the molecular weight (average) is not known for the mixture, it can be approximated by the following equation:

$$\text{M.W.} = \% \text{ Al} + 0.88 \% \text{ Ar} + 0.5(\text{B.P. } ^\circ\text{C.}) - 100$$

B⁴ *Welding Fumes* — Total Particulate
5 mg/m³ (N.O.C.)^{q)}

In electric or oxy-gas welding of iron or steel, galvanized iron or aluminum, the chief components of the fume are ordinarily oxides of iron, zinc or aluminum. Other fumes, as well as toxic gases may be present in significant amounts, however. Manganese, silicate and organic binders are commonly present in the coatings of welding rods for ferrous metals; fluoride in those for aluminum. And elements such as arsenic, copper, are sometimes found. Many aluminum rods contain appreciable quantities of silicon, and some have traces of beryllium. In shielded arc welding, ozone is often formed, and carbon monoxide has been reported when CO₂ was utilized as shield gas. Oxides of nitrogen are more likely to be associated with oxy-gas than with electric arc welding.

Because of the additional hazard created by toxic gases and traces to small amounts of fumes of more toxic elements, the total fume concentration, when welding iron, mild steel or aluminum, should not exceed 5 mg/m³ in the breathing zone of the welder or others in the area.

The fumes from stainless steel, cadmium- or lead-coated steel, and other metals such as copper and nickel are considerably more toxic and concentrations should generally be kept at a lower level, depending on the TLV's of the metals involved. In addition, in the shielded arc welding of aluminum, relatively large amounts of ozone may be generated, and the concentration of this gas may largely determine the health hazard.

*Trade Names: Algoflon, Fluon, Halon, Teflon, Tetran

q) Not otherwise classified.

APPENDIX C

C.1 THRESHOLD LIMIT VALUES
FOR MIXTURES

When two or more hazardous substances are present, their combined effect, rather than that of either individually, should be given primary consideration. In the absence of information to the contrary, the effects of the different hazards should be considered as additive. That is, if the sum of the following fractions,

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n}$$

exceeds unity, then the threshold limit of the mixture should be considered as being exceeded. C_1 indicates the observed atmospheric concentration, and T_1 the corresponding threshold limit (See Example 1A.a. and 1A.c.).

Exceptions to the above rule may be made when there is good reason to believe that the chief effects of the different harmful substances are not in fact additive, but *independent* as when purely local effects on different organs of the body are produced by the various components of the mixture. In such cases the threshold limit ordinarily is exceeded only when at least one member of

the series $\left(\frac{C_1}{T_1} + \text{or} + \frac{C_2}{T_2} \text{ etc.} \right)$ itself has a value exceeding unit (See Example 1A. c.).

Antagonistic action or potentiation may occur with some combinations of atmospheric contaminants. Such cases at present must be determined individually. Potentiating or antagonistic agents are not necessarily harmful by themselves. Potentiating effects of exposure to such agents by routes other than that of inhalation is also possible, e.g. imbibed alcohol and inhaled narcotic (trichloroethylene). Potentiation is characteristically exhibited at high concentrations, less probably at low.

When a given operation or process characteristically emits a number of harmful dusts, fumes, vapors or gases, it will frequently be only feasible to attempt to evaluate the hazard by measurement of a single sub-

stance. In such cases, the threshold limit used for this substance should be reduced by a suitable factor, the magnitude of which will depend on the number, toxicity and relative quantity of the other contaminants ordinarily present.

Examples of processes which are typically associated with two or more harmful atmospheric contaminants are welding, automobile repair, blasting, painting, lacquering, certain foundry operations, diesel exhausts, etc. (Example 2 in 1A.a.).

THRESHOLD LIMIT VALUES
FOR MIXTURES

EXAMPLES

1A.a. General case, where air is analyzed for each component:

a. *Additive effects.* (Note: *It is essential that the atmosphere be analyzed both qualitatively and quantitatively for each component present, in order to evaluate compliance or noncompliance with this calculated TLV.*)

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} + \dots = 1$$

Example No. 1A.a: Air contains 5 ppm of carbon tetrachloride (TLV = 10 ppm) 20 ppm of ethylene dichloride (TLV = 50 ppm) and 10 ppm of ethylene dibromide (TLV = 20 ppm)

Atmospheric concentration of mixture = 5 + 20 + 10 = 35 ppm of mixture

$$\frac{5}{10} + \frac{20}{50} + \frac{10}{20} = \frac{25 + 20 + 25}{50} = 1.4$$

Threshold Limit is exceeded. Furthermore, the TLV of this mixture may be calculated by reducing the total fraction to 1.0; i.e.

$$\text{TLV of mixture} = \frac{35}{1.4} = 25 \text{ ppm}$$

1A.b. Special case when the source of contaminant is a liquid mixture and the

atmospheric composition is *assumed* to be similar to that of the original material; e.g. on a time weighted average exposure basis, all of the liquid (solvent) mixture eventually evaporates.

Additive effects (approximate solution)

1. The percent composition (by weight) of the liquid mixture is known, the TLVs of the constituents must be listed in mg/m³.

(Note: In order to evaluate compliance with this TLV, field sampling instruments should be calibrated, in the laboratory, for response to this specific quantitative and qualitative air-vapor mixture, and also to fractional concentrations of this mixture; e.g., 1/2 the TLV; 1/10 the TLV; 2 × the TLV; 10 × the TLV; etc.)

TLV of mixture =

$$\frac{1}{\frac{f_a}{\text{TLV}_a} + \frac{f_b}{\text{TLV}_b} + \frac{f_c}{\text{TLV}_c} + \cdots + \frac{f_n}{\text{TLV}_n}}$$

Example No. 1: Liquid solvent contains
(by weight) 50% heptane
(TLV = 2000 mg/m³)
30% methylene chloride
(TLV = 1740 mg/m³)
20% perchlorethylene
(TLV = 670 mg/m³)

$$\begin{aligned}\text{TLV of mixture} &= \frac{1}{\frac{0.5}{1600} + \frac{0.3}{360} + \frac{0.2}{670}} \\ &= \frac{1}{0.00031 + 0.00083 + 0.0003} = \frac{1}{0.00144} \\ &= 692 \text{ mg/m}^3\end{aligned}$$

To convert to ppm, consult TLV list:

50% heptane = 200 ppm
30% methylene chloride = 33 ppm
20% perchloroethylene = 20 ppm

TLV of mixture: 200 + 33 + 20 = 253 ppm

1A.c. Independent effects.

Air contains 0.15 mg/m³ of lead (TLV, 0.15) and 0.7 mg/m³ of sulfuric acid (TLV, 1).

$$\frac{0.15}{0.15} = 1; \quad \frac{0.7}{1} = 0.7$$

Threshold limit is not exceeded.

1B.a. General Exact Solution for Mixtures of N Components With Additive Effects and Different Vapor Pressures.

$$(1) \quad \frac{C_1}{T_1} + \frac{C_2}{T_2} + \cdots + \frac{C_n}{T_n} = 1;$$

$$(2) \quad C_1 + C_2 + \cdots + C_n = T,$$

$$(2.1) \quad \frac{C_1}{T} + \frac{C_2}{T} + \cdots + \frac{C_n}{T} = 1.$$

$$(3) \quad C_1 = ap_1,$$

and by Raoult's Law,

$$(4) \quad p_1 = F_1 p_1^\circ.$$

Combine (3) and (4) to obtain

$$(5) \quad C_1 = aF_1 p_1^\circ.$$

Combining (1), (2.1) and (5),

we obtain

$$(6) \quad \frac{F_1 p_1^\circ}{T} + \frac{F_2 p_2^\circ}{T} + \cdots + \frac{F_n p_n^\circ}{T} =$$

$$\frac{F_1 p_1^\circ}{T_1} + \frac{F_2 p_2^\circ}{T_2} + \cdots + \frac{F_n p_n^\circ}{T_n}$$

and solving for T,

$$(6.1) \quad T = \frac{F_1 p_1^\circ + F_2 p_2^\circ + \cdots + F_n p_n^\circ}{\frac{F_1 p_1^\circ}{T_1} + \frac{F_2 p_2^\circ}{T_2} + \cdots + \frac{F_n p_n^\circ}{T_n}}$$

$$\text{or } \frac{i}{\Sigma} = n F_1 p_1^\circ$$

$$(6.2) \quad T = \frac{i = 1}{\frac{i = n}{\Sigma}}$$

$$i = \frac{F_1 p_1^\circ}{T_1}$$

T — Threshold Limit Value in ppm.

C — Vapor concentration in ppm.

p — Vapor pressure of component in solution.

p° — Vapor pressure of pure component.

F — Mol fraction of component in solution.

a — A constant of proportionality.

Subscripts 1, 2, . . . n relate the above quantities to components 1, 2, . . . n, respectively.

Subscript i refers to an arbitrary component from 1 to n.

Absence of subscript relates the quantity to the mixture.

- 1B.b. Solution to be applied when there is a reservoir of the solvent mixture whose composition does not change appreciably by evaporation.

*Exact Arithmetic Solution
of Specific Mixture*

Solvent	Mol. wt.	Density	TLV	p° at 25°C	Mol fraction in half-and- half solution by volume
Trichloro- ethylene (1)	131.4	1.46 g/ml	100	73mm Hg	0.527
Methyl- chloro- form (2)	133.42	1.33 g/ml	350	125mm Hg	0.473

$$F_{1p_1}^\circ = (0.527) (73) = 38.2$$

$$F_{2p_2}^\circ = (0.473) (125) = 59.2$$

$$TLV = \frac{38.2 + 59.2}{\frac{38.2}{100} + \frac{59.2}{350}} = \frac{(97.4) (350)}{133.8 + 59.2} =$$

$$\frac{(97.4) (350)}{193.0} = 177$$

TLV = 177 ppm (Note difference in TLV when account is taken of vapor pressure and mol fraction in comparison with the above example where such account is not taken.)

2. A mixture of one part of (1) parathion (TLV, 0.1) and two parts of (2) EPN (TLV, 0.5).

$$\frac{C_1}{0.1} + \frac{C_2}{0.5} = \frac{C_m}{C_m} \quad C_2 = 2C_1$$

$$C_m = 3C_1$$

$$\frac{C_1}{0.1} + \frac{2C_1}{0.5} = \frac{3C_1}{T_m}$$

$$\frac{7C_1}{0.5} = \frac{3C_1}{T_m}$$

$$T_m = \frac{1.5}{7} = 0.21 \text{ mg/m}^3$$

- 1C. TLV for Mixtures of Mineral Dusts.

For mixtures of biologically active mineral dusts the general formula for mixtures may be used.

For a mixture containing 80% talc and 20% quartz, the TLV for 100% of the mixture is given by:

$$TLV = \frac{1}{\frac{0.8}{20} + \frac{0.2}{2.9}} = 8.0 \text{ mppcf}$$

Essentially the same result will be obtained if the limit of the more (most) toxic component is used provided the effects are additive. In the above example the limit for 20% quartz is 10 mppcf.

For another mixture of 25% quartz, 25% amorphous silica and 50% talc:

$$TLV = \frac{1}{\frac{0.25}{2.9} + \frac{0.25}{20} + \frac{0.5}{20}} = 7.0 \text{ mppcf}$$

The limit for 25% quartz approximates 8 mppcf.

APPENDIX D

PERMISSIBLE EXCURSIONS FOR TIME-WEIGHTED AVERAGE (TWA) LIMITS

The Excursion TLV Factor in the Table automatically defines the magnitude of the permissible excursion above the limit for those substances not given a "C" designation; i.e., the TWA limits. Examples in the Table show that nitrobenzene, the TLV for which is 1 ppm, should never be allowed to exceed 3 ppm. Similarly, carbon tetrachloride, TLV 10 ppm, should never be allowed to exceed 20 ppm. By contrast, those substances with a "C" designation are not subject to the excursion factor and must be kept at or below the TLV ceiling.

These limiting excursions are to be considered to provide a "rule-of-thumb" guidance for listed substances generally, and may not provide the most appropriate excursion for a particular substance e.g., the permissible excursion for CO is 400 ppm for 15 minutes.

For appropriate excursions for 142 substances consult Pa. Rules & Regs., Chap. 4, Art. 432, and "Acceptable Concentrations," ANSI.

Substance	TLV	Excursion Factor	Max. Conc. Permitted for short time
	ppm		ppm
Nitrobenzene	1	3	3
Carbon tetrachloride	10	2	20

Substance	TLV	Excursion Factor	Max. Conc. Permitted for short time
	ppm		ppm
o-Dichlorobenzene	50	1.5	75
Acetone	1000	1.25	1250
Boron trifluoride	C 1	—	1
Butylamine	C 5	—	5

EXCURSION FACTORS

For all substances not bearing C notation

TLV	Excursion Factor
>0-1 (ppm or mg/m ³)	=3
>1-10 "	=2
>10-100 "	=1.5
>100-1000 "	=1.25

The number of times the excursion above the TLV is permitted is governed by conformity with the Time-Weighted Average TLV.

BASIS FOR ASSIGNING LIMITING "C" VALUES

By definition in the Preface, a listed value bearing a "C" designation refers to a "ceiling" value that should not be exceeded; all values should fluctuate below the listed value. This, in effect, makes the "C" designation a maximal allowable concentration (MAC). In general, the bases for assigning or not assigning a "C" value rest on whether excursions of concentration above a proposed limit *for periods up to 15 minutes* may result in a) intolerable irritation, b) chronic, or irreversible tissue change, or c) narcosis of sufficient degree to increase accident proneness, impair self-rescue or materially reduce work efficiency.

APPENDIX E**Some Nuisance Particulates ^{q)}**TLV, 30 mppcf or 10mg/m³

Alundum (Al ₂ O ₃)	Kaolin
Calcium carbonate	Limestone
*Calcium silicate	Magnesite
Cellulose (paper fiber)	Marble
Portland Cement	*Mineral Wool
Corundum (Al ₂ O ₃)	Fiber
Emery	Pentaerythritol
Glass, fibrous ^{r)} or dust	Plaster of Paris
Glycerin Mist	Rouge
Graphite (synthetic)	*Siliccn
Gypsum	Silicon Carbide
Vegetable oil mists	Starch
(except castor,	Sucrose
cashew nut, or	Tin Oxide
similar irritant	Titanium Dioxide
oils)	*Zinc Stearate

q) When toxic impurities are not present,
e.g. quartz < 1%

r) <7μm in diameter

APPENDIX F**Some Simple Asphyxiants ^{s)}**

Acetylene	Hydrogen
Argon	Methane
Butane	Neon
Ethane	Nitrous oxide
Ethylene	Propane
Helium	

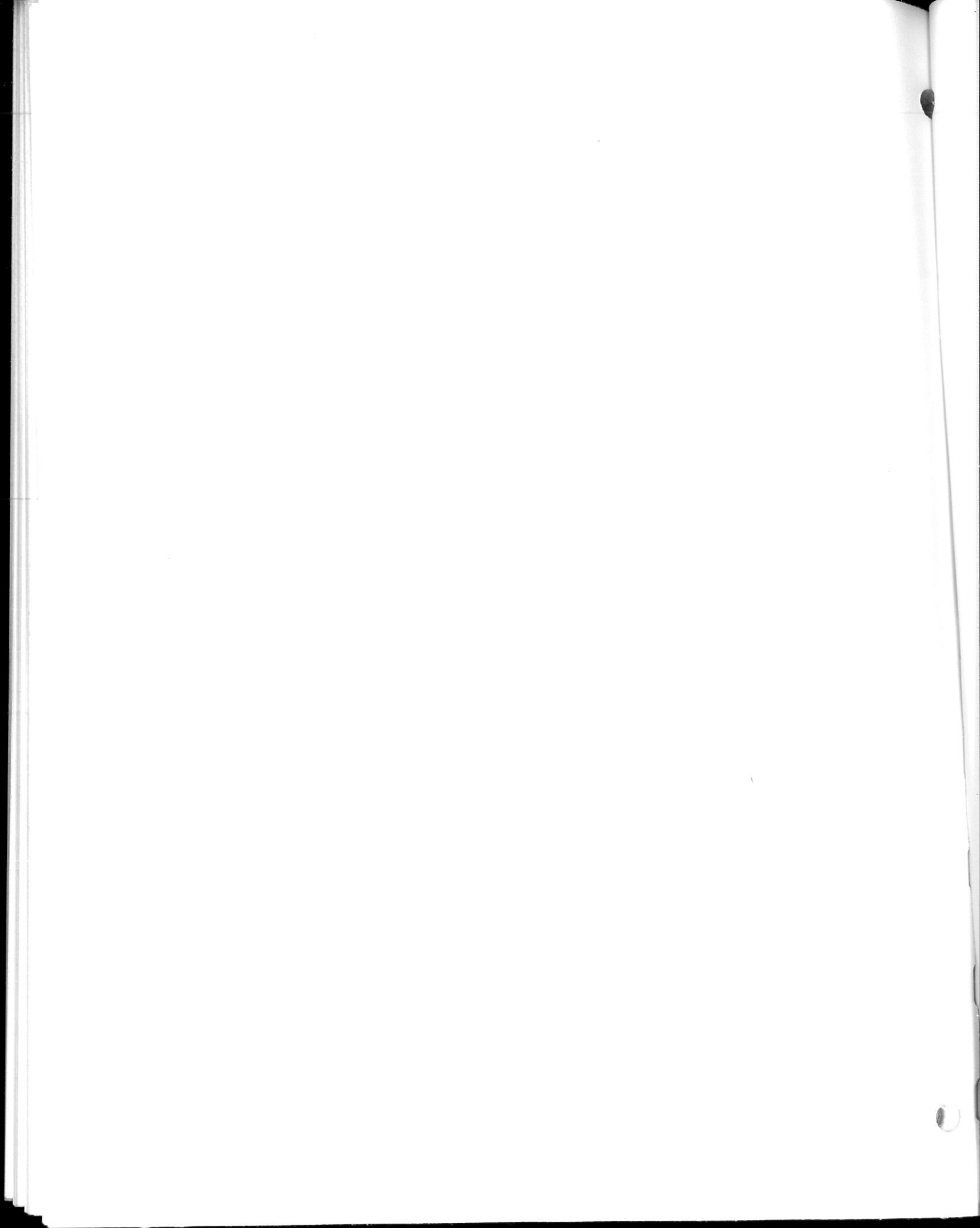
s) As defined on pg. 6.

*1974 Addition.

APPENDIX B

THE NATIONAL RESEARCH COUNCIL OF THE NATIONAL
ACADEMY OF SCIENCES
EMERGENCY EXPOSURE LIMITS (EELs)*

* These limits are promulgated by the National Research Council of the National Academy of Sciences for use by the Department of Defense. Before applying these values to specific situations, the Bureau of Medicine and Surgery (BUMED) Code 56 or the Navy Environmental Health Center must be consulted.



APPENDIX B

EMERGENCY EXPOSURE LIMITS (EEL's)

All levels in parts per million (ppm) unless otherwise stated.

<u>Compound</u>	<u>10 min.</u>	<u>30 min.</u>	<u>60 min.</u>	<u>Date Set</u>
Acetone			15,000	1966
Acrolein			0.2*	1969
Aluminum fluoride	25 mg/M ³	10 mg/M ³	7 mg/M ³	1969
Aluminum oxide	50 mg/M ³	25 mg/M ³	15 mg/M ³	1969
Ammonia			400	1966
Ammonia (anhydrous)	500	300	300	1968
Arsine			1.0	1966
Benzene			100	1966
Boron trifluoride	10	5	2	1969
Bromine pentafluoride	3*	1.5*	0.5*	1968
Carbon dioxide			25,000	1966
Carbon disulfide	200	100	50	1965
Carbon monoxide				
Normal activity	1,500	800	400	1965
Mental acuity	1,000	500	200	1965
Chlorine pentafluoride	3*	1.5*	0.5*	1968
Chlorine trifluoride	7	3	1	1962
Chloroform			400	1970
Diborane	10	5	2	1968
Dichlorodifluoromethane (R-12)			30,000	1966
1,2-Dichloro-1,1,2,2-tetrafluoroethane (R-114)			30,000	1966
1,1-Dimethylhydrazine	100	50	30	1968
Ethyl Alcohol			1,000	1960
Ethylene glycol			50	1965
Ethylene oxide	650	400	250	1968
Fluorine	15	10	5	1967
Fluorotrichloromethane (R-11)			30,000	1966
Formaldehyde			3*	1969
Hydrazine	30	20	10	1968
Hydrogen chloride	30	20	10	1966
Hydrogen fluoride	20	10	8	1965
Hydrogen sulfide	200	100	50	1969
Isopropyl Alcohol			400	1960

* TENTATIVE LEVELS

EEL

<u>Compound</u>	<u>10 min.</u>	<u>30 min.</u>	<u>60 min.</u>	<u>Dates</u>
JP-5	5 mg/l*	5 mg/l*	2.5 mg/l*	1968
Methyl Alcohol			1,000	1966
Methylchloroform			500	1966
Monoethanolamine			50	1966
Monomethylhydrazine	90	30	15	1970
Nitrogen dioxide	30	20	10	1965
Nitrogen trifluoride		100	50	1961
Nitrous oxide			≤50,000	1970
Oxygen difluoride	0.5	0.2	0.1	1964
Ozone			1.0	1966
Perchloryl fluoride	50	20	10	1968
Phosgene			1.0	1966
Sodium hydroxide	4.0 mg/M ³	4.0 mg/M ³	2.0 mg/M ³	1965
Stibine			1.0	1966
Sulfur dioxide	30	20	10	1966
Sulfuric acid	5 mg/M ³	2 mg/M ³	1 mg/M ³	1969
Tellurium hexafluoride	1.0	0.4	0.2	1966
Toluene			200	1966
1,1,2-Trichloro-1,2,2-trifluoroethane (R-113)			1,500	1969
Unsymmetrical Dimethylhydrazine	100	50	30	1965
Xylene			200	1966

* TENTATIVE LEVELS

APPENDIX C

GLOSSARY

GLOSSARY

ACGIH:	American Conference of Governmental Industrial Hygienists
Acne:	Oil dermatitis
Acute:	Not chronic; having a short and relatively severe course. Sudden onset.
Aerosols:	Liquid droplets or solid particles dispersed in air, that are of fine enough particle size (0.01 to 100 microns) to remain so dispersed for a period of time
Albumin:	A protein material found in animal and vegetable tissues.
Albuminuria:	The presence of albumin or other protein substances, such as serum globulin, in the urine.
Aliphatic:	Pertaining to an open chain carbon compound. Usually applied to petroleum products derived from a paraffin base and having a straight or branched chain, saturated or unsaturated molecular structure.
Allergy:	An abnormal response of a hypersensitive person to chemical and physical stimuli. Allergic manifestations of major importance occur in about ten per cent of the population.
Alveoli:	Tiny air sacs of the lungs, formed by a dilation at the end of a bronchiole; through the thin walls of the alveoli, the blood takes in oxygen and gives up its carbon dioxide in the process of respiration.
Anaphylaxis:	Hypersensitivity resulting from sensitization following prior contact with a chemical or protein.
Anemias:	Deficiency in the hemoglobin and erythrocyte content of the blood. Term refers to a number of pathologic states that may be due to a large variety of causes and appear in many different forms.

GLOSSARY

Antibody:	Any of the body globulins that combine specifically with antigens and neutralize toxins, agglutinate bacteria or cells, and precipitate soluble antigens. It is found naturally in the body or produced by the body in response to the introduction into its tissues of a foreign substance.
Antigen:	A substance that, when introduced into the body, stimulates the production of an antibody.
Asphyxia:	Suffocation from lack of oxygen. Chemical asphyxia is produced by a substance, such as carbon monoxide, that combines with hemoglobin to reduce the blood's capacity to transport oxygen. Simple asphyxia is the result of exposure to a substance, such as carbon dioxide, that displaces oxygen.
Asthma:	Constriction of the bronchial tube muscles, in response to irritation, allergy, or other stimulus.
Atm:	Atmospheres; $1 \text{ atm} = 760 \text{ mm Hg}$ (14.69 lbs/in^2) of air pressure.
Bronchitis:	Inflammation of the bronchi or bronchial tubes.
"C":	Ceiling value - See Appendix A for discussion of meaning and uses.
°C:	Degrees Celsius or Centigrade: $0^{\circ}\text{C} = 32^{\circ}\text{F}$, the temperature at which water freezes; $100^{\circ}\text{C} = 212^{\circ}\text{F}$, the temperature at which water boils. For conversion of $^{\circ}\text{C}$ to $^{\circ}\text{F}$, use the formula, $^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$.
cal:	Calorie - the heat required to raise the temperature of 1 gram of water 1°C @ 1 atm pressure.
Carcinogen:	Cancer-producing agent.

cfm:	Cubic feet per minute.
Chronic:	Persistent, prolonged, repeated.
Ci:	Curie - A unit of radioactivity, 3.7×10^{10} disintegrations/sec.
Cilica:	Tiny hair-like "whips" in the bronchi and other respiratory passages that aid in the removal of dust trapped on these moist surfaces.
Colitis:	Irritation and inflammation of the large intestine (colon).
Conjunctivitis:	Inflammation of the lining of the eyelids.
Corrosive Chemical:	Chemical which, when in contact with living tissue or inanimate materials, will either materially damage these items by chemical action or are likely to cause fire when in contact with materials or other chemicals.
Cutaneous Route:	Through the skin.
Cyanosis:	Blue appearance of the skin, especially on the face and extremities, indicating a lack of sufficient oxygen in the arterial blood.
Dermatitis:	Skin inflammation.
Dyspnea:	Shortness of breath, difficult or labored breathing.
EEL:	Emergency Exposure Limit - See Appendix B and Introduction for discussion of meaning and use.
Emetic:	A material that induces vomiting.
°F:	Degrees Fahrenheit: $32^{\circ}\text{F} = 0^{\circ}\text{C}$, the temperature at which water freezes; $212^{\circ}\text{F} = 100^{\circ}\text{C}$, the temperature at which water boils. For conversion of $^{\circ}\text{C}$ to $^{\circ}\text{F}$, use the formula, $^{\circ}\text{C} = 5/9(^{\circ}\text{F} - 32)$.

GLOSSARY

Flammable Gas:	Any gas which, when mixed with air in the proper proportion, will burn readily.
Flammable Liquid:	<p>Flammable liquids are divided into two classes, according to NFPA Standard No. 30:</p> <p>Class I liquids include those having flash points below 100°F, and may be thus subdivided:</p> <p>Class IA-those having flash points below 73°F, and having a boiling point below 100°F.</p> <p>Class IB-those having flash points below 73°F, and having a boiling point at or above 100°F.</p> <p>Class IC-those having flash points at or above 73°F and below 100°F.</p> <p>Class II flammable liquids having flash points at or above 100°F but below 140°F.</p>
Flash Point:	The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture with air and produce a flame when a source of ignition is present. Two tests are used - open cup and closed cup.
fpm:	Linear feet per minute.
Gastritis:	Inflammation of the stomach.
GI:	Gastrointestinal.
gm:	Gram (a unit of weight) - 1 gm = 0.035 ounces; 454 gm = 1 lb.
Hazardous Substance:	Any material which has one or more of the following qualities: toxic, corrosive, irritating, sensitizing, flammable, or explosive.
Hematuria:	Blood in the urine.

GLOSSARY

Hemolysis:	Breakdown of red blood cells with liberation of hemoglobin.
Hemoptysis:	Bleeding from the lungs, spitting blood, or blood-stained sputum.
Hemorrhage:	Bleeding; especially, profuse bleeding, as from a ruptured or cut blood vessel (artery or vein).
Hepatitis:	Inflammation of the liver.
Hg:	The symbol for the element of Mercury; used as the standard for measuring pressure.
Inflammation:	The reaction of body tissue to injury, whether by infection or trauma. The inflamed area is red, hot, swollen, and usually painful.
Ingestion:	(a) The process of taking substances into the body, as food, drink, medicine, etc. (b) With regard to certain cells, the act of engulfing or taking up bacteria and other foreign matter.
Intoxication:	Means either drunkenness or poisoning.
Irritant:	A primary irritant is one that has been found to produce an irritating effect at the area of the skin contact. Although they affect everyone, they do not produce the same degree of irritation.
Ischemia:	Loss of blood supply to a particular part of the body.
Jaundice:	Yellowish coloration caused by the presence of bile in the skin.
Kcal:	Kilocalorie - 1000 calories [See calorie]; also abbreviated Cal.
Kg:	Kilogram - 1000 grams [See gram (gm)].
l:	Liter - A unit (metric) of liquid measure. 1 liter = 1.0567 quarts (qts).

GLOSSARY

Laryngitis:	Inflammation in the larynx.
Larynx:	The organ by means of which the voice is produced. It is situated at the upper part of the trachea.
Latent Period:	The time which elapses between exposure and the first manifestation of damage.
Lesion:	An injury, damage, or abnormal change in a tissue or organ, especially one that impairs the function of the part involved or, even if it causes no impairment of function, expresses a symptom or sign of a disease.
Lethal:	Capable of causing death.
Leukocytosis:	An abnormal increase in the number of white blood cells.
Leukopenia:	A serious reduction in the number of white blood cells.
Localized:	Restricted to one spot or area in the body and not spread all through it - contrast with systemic.
m or M:	Meter - A unit (metric) of measure. One meter = 39.36 inches.
Metabolism:	Describes the physical and chemical changes that are constantly taking place in the billions of cells that make up the living body.
mg:	Milligram - One thousandth of a gram [See gram (gm)].
mg/M ³ :	Milligrams per cubic meter - a unit used for expressing concentrations in air of substances in terms of weight per unit volume.
ml:	Milliliter - One thousandth of a liter [See liter (l)].
m.p.p.c.f.:	Million particles per cubic foot. A unit used for expressing particulate matter concentrations in air in terms of the number of particles per unit volume.

GLOSSARY

mr:	Milliroentgen - One thousandth of a roentgen [See roentgen (r)].
Mucous Membranes:	Lining of the hollow organs of the body, notably the nose, mouth, stomach, intestines, bronchial tubes, and urinary tract.
Neuritis:	Inflammation of the peripheral nerves.
Oxidizer:	A substance that yields oxygen readily and stimulates, supports, or initiates combustion and burning.
Palpitation:	Rapid heartbeat of which a person is acutely aware.
Parenchyma:	The essential or functional elements of a bodily organ, the working tissue.
pC:	Picocurie - 10^{-12} curies [See curie(Ci)].
Physiology:	The science and study of the functions or actions of living organisms.
Pleuritis:	Inflammation of the pleura (lining of the lung).
Pneumoconiosis:	Dusty lungs, as a result of the continued inhalation of various kinds of dusts and other particles.
Pneumoconiosis-producing Dust:	Dust, which when inhaled, deposited, and retained in the lungs, may produce signs, symptoms and findings of pulmonary disease.
Pneumonitis:	Inflammation of the lungs characterized by an outpouring of fluid in the lungs. Pneumonia is the same condition, but involves greater quantities of fluid.
Poison:	Any material that will lead to fatal results when taken into the body by inhalation, ingestion, or through the skin.
ppb:	Parts per billion - A unit to express concentrations (See ppm, below).
ppm:	Parts per million - Parts of vapor or gas per million parts of air by volume at 25°C and 760 mm Hg pressure.

GLOSSARY

Proteolytic:	Capable of splitting or digesting proteins into simpler compounds.
PSI or psi:	Pounds per square inch - A unit to express pressure.
Pulmonary Edema:	Fluid collection in the lung.
Radioactive Material:	Any material which either spontaneously emits particles or gamma radiation, or emits X-radiation following orbital electron capture or by undergoing spontaneous fission.
Rash:	Abnormal reddish coloring or blotch on some part of the skin.
Respirator:	An apparatus used for providing clean breathing air.
Rhinitis:	Inflammation of the mucous membrane lining in the nasal passages.
Roentgen (r):	A measure of the ionizing potential of an ionizing radiation source. $1\text{ r} = 1\text{ coulomb/kg.}$
Shock:	Primarily, the rapid fall in blood pressure following injury, operation, or the administration of anesthesia.
Spasm:	Tightening or contraction of any set(s) of muscles.
Subacute:	An illness or condition that is not quite as serious or as dangerous as the acute phase but may become so if not properly managed.
Symptom:	Any bit of evidence from a patient that he is sick; the subjective feelings of the patient.
Syncope:	Fainting spell.
Syndrome:	A collection, constellation, or concurrence of signs and symptoms, usually of disease.

GLOSSARY

Systemic:	Spread throughout the body, affecting all body systems and organs, not localized in one spot or area.
Tetany:	A condition marked by muscular twitching, tremors, spasms, cramps, or convulsions.
TLV:	Threshold Limit Value - See Appendix A for meaning and usage.
Toxic:	Capable of producing injury or illness from contact, ingestion or inhalation.
Trachea:	The windpipe or tube that conducts air to and from the lungs. It extends between the larynx above and the point where it divides into two bronchi, below.
Trauma:	An injury or wound brought about by an outside force.
Tremor:	Involuntary shaking, trembling, or quivering.
TWA:	Time Weighted Average - See Appendix A for meaning and usage.
USP:	United States Pharmacopoeia; pharmaceutical grade.
Vapor Pressure:	The pressure exerted by a vapor or gas on its surroundings, usually measured in either mm of Hg or lbs/in ² .
Vesicant:	An agent that causes blisters.
Vesicle:	A small blister on the skin.
Virulent:	Extremely poisonous or venomous; capable of overcoming bodily defense mechanisms.
Viscera:	Internal organs of the abdomen.
Volatile:	Giving off vapors.

